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U.S. RESOURCES: A TALLY SHEET

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Coming Next Month

America's Polluted Environment

The July, 1970, issue of Current History will survey the pollution of air, water and land in the United States. Six authors will discuss:

Our Ecological Crisis
by CARROLL QUIGLEY, Georgetown University;

Solid Wastes and Land Pollution
by FRANK BUTRICO, Battelle Memorial Institute;

Air Pollution
by DAVID NEWMAN, McGraw-Hill Publications;

Water Pollution
by HARVEY LIEBER, The American University;

Pollution and a Concerned Public
by GAYLORD NELSON, U.S. Senate;

Private Interests and Public Lands
by ROBERT GILMOUR, Columbia University.

Also in this series:

U.S. Resources: A Tally Sheet, June, 1970
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HIGH SCHOOL DEBATERS: Note these 3 issues on the 1970–1971 N.U.E.A. DEBATE TOPIC.

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Current History

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What is the status of America's natural resources? How badly polluted are the air, water and soil of the United States? What can we do to remedy the damage we have been inflicting on our environment? A three-issue study offers historical, scientific, political and economic answers to these questions. In tracing the slow growth of government control over natural resources, our first author notes that "Early Americans won their fierce battle against nature largely through their own individual efforts and . . . came to regard any restrictions on their . . . activities as vestiges of . . . European paternalism."

Government's Historical Role in Conservation

By William G. Carleton

Professor Emeritus of History, University of Florida

During the first three centuries of their history (1607–1900), Americans waged a hard fight to survive and control their physical environment. They wastefully exploited their country's resources and in general resented any government interference with that exploitation.

When during the seventeenth century repeated small groups of Englishmen set out to colonize mainland North America, they confronted, 3,000 miles from civilization, a raw battle of survival against an intimidating environment filled with the perils of the unknown. For these small colonizing groups, the margin of safety was so narrow that inactivity, illness, the death of a member, the loss of a musket, an axe, a plow, a cow or an ox might spell the difference between survival and disaster.

The settlers of the first American frontier, the primeval Atlantic frontier of the first half of the seventeenth century, encountered brutal hardships penetrating the unending and thickly woven forest canopy and the tenacious forest underbrush to make small clearings of sickly sunlight so that a little corn might be grown. There were more injuries from the felling of trees and the toppling of deadened ones than from Indians. Settlers struggled to protect their livestock from wolves, bears, panthers and wildcats. They struggled to protect themselves from sinking into swamps, and from being poisoned by the unfamiliar plant life; to save their crops from the vast variety of prolific small woods animals, birds, reptiles and insects (a short visitation of a flock of blackbirds could be a disaster, and squirrels spread such havoc that organized hunts had to be waged against them). They learned to detect poison ivy, water sumac and rattlesnakes; to fight off the swarms of wood ticks, gnats, fleas, blue and green flies and mosquitoes; and they attempted to cope with malaria, intestinal "bloody flux," and with typhoid while they fought the Indians.

Physically, Europe was a tame and manageable continent compared to North America, and it took the colonists a long time to adjust themselves to the physical turbu-

lence of the new world. They faced a climate more violent and unpredictable than the European—extreme summer heat and winter cold; quick seasonal changes; marked oscillations in temperature from day to day and even from hour to hour; severe blizzards; late and early freezes; uprooting of the grain when in spring the daytime thaws alternated with the freezes of the night; terrifying electrical storms; hurricanes and torrential rains; sudden cloudbursts which washed out the seeds and sproutings; the perishing of grain when the cold of winter was not accompanied by the usual protective snows; tempestuous rivers that brought devastating floods. America's captious climate even made difficult the building of fences that would stay "put." When the frost left the ground rapidly, the posts were heaved up and the labor of months was lost. After much trial and error, the celebrated wooden rail zig-zag fence was developed, and this resisted the heavings of the earth. Most terrifying were the forest fires, which usually had their origins in the carelessness of the settlers themselves. Sometimes a giant fire would sweep for 50 miles, consuming clearings, dwellings, livestock and all manner of forest life.

There were compensations for these rigors in the wide availability of land, a free range, an abundance of game and wildlife for food, and the accessibility of furs, skins and hides for clothing and bedding. Gradually there emerged a corn-pork-wood economy. Corn was prepared and eaten in a great variety of ways; it was fermented into spirits; it was fed to fowl, cows and hogs; its husks were made into mattresses and its stalks and dried leaves were used for forage. Pork became the chief American meat staple because hogs adapted to the American woods better than did the other domesticated animals and were more prolific and matured faster than cattle. The wood of the forest was used for dwellings, outhouses, fuel, furniture, tableware, jars, jugs, buckets, spinning wheels, looms, barrows, carts, rude wagons, canoes, flatboats. Even when the woods economy could not supply their needs—as in the cases of farm implements, carpenter tools and firearms—it was from the forest that colonial Americans obtained their first cash products—furs and hides, potash, turpentine and naval stores, masts, clapboards, barrel staves—with which to make purchases in England. In time, timber came to be used for shipbuilding, which in turn made possible the fishing industries and American participation in the carrying trade. Even the developing towns and tobacco and rice plantations were at bottom dependent on the corn-pork-wood economy.

RESISTANCE TO GOVERNMENTAL RESTRAINTS

Colonials set the pattern of American self-reliance and resistance to organized social and political restraints. Early Americans won their fierce battle against nature largely through their own individual efforts and spontaneous neighborhood cooperation. They came to regard any restrictions on their economic activities as vestiges of that European paternalism embodied in monarchical governments, aristocratic landlords and traditional communal villages. While the British government regulated the external colonial trade with some effectiveness (although smuggling and sundry other violations of the trade regulations were enormous), it never succeeded in imposing effective internal restrictions on the exploitation of American resources.

When in 1711, 1722, and 1729, the British government enacted laws to prohibit the cutting down of white pine trees on the crown lands (with the view to preserving them for shipbuilding), the colonists simply ignored this prohibition. They continued to invade the public land, as they did the land of remote private owners, and to take what they wanted, including white pines. The British government, believing that the colonists certainly had enough land east of the Appalachians to meet their needs and wishing to preserve the lands to the west for the fur traders and the Indians, sought to stay the movements and activities of the colonists in the lands west of the Appalachians by issuing the Proclamation of 1763. The outcries of

land companies, land speculators and prospective settlers were such that the government was forced to move the demarcation line farther west. However, any legislation which encouraged the colonists to do what they wanted to do anyway—as when colonial governments sought to decimate squirrels and paid cash bounties for squirrel tails—was welcomed.

Already in colonial times there was in progress the "Great Barbecue," in which a small population would appropriate for private use the vast resources of a continent—and wastefully exploit them. Many colonists simply squatted on the land and never bothered to get legal title and these, together with many who did get legal title, often made it a practice to gut the virgin soil and forest of one area and then to move on to another.

Life on succeeding frontiers was primitive and called for a constant battle against the physical environment, but it was not primeval, as it had been along the original Atlantic frontier. As settlers moved beyond the fall line and into the colonial backcountry in the early and middle eighteenth century, and then beyond the Appalachians in the late eighteenth century, they had advantages not possessed by the original coastal settlers. They could communicate with the older settlements. They knew what to expect, and they profited from the experiences of the older settlers. The eighteenth century pioneers adopted the log cabin, superior to the usual crude clapboard dwellings of the coastal frontier and requiring fewer tools and less labor. The seventeenth century pioneers had only the three-pound, shallow-cutting European axe, but the eighteenth century pioneers had the American seven-pound axe with a deep cutting edge. The seventeenth century pioneers had only English matchlocks, blunderbusses and muskets, but the late eighteenth century pioneers had the more precise Pennsylvania or Kentucky rifle.

THE BATTLE AGAINST DISEASE

Americans of the first half of the nineteenth century were an unhealthy people. Nathaniel Hawthorne, living in England during the mid-1850's, confided in his diary that Englishmen were a less emaciated and sallow breed, a healthier folk, than were Americans. The great killers were the communicable diseases. In rapidly expanding frontier America, there were vast areas of freshly cleared and undrained land, and across the whole country there were clearings abandoned by settlers who had moved on, leaving their clearings to degenerate into quagmires. Every hamlet had its stagnant millpond. In towns, there were cesspools and open privies. Houses were not screened from flies and mosquitoes. Fleas, bedbugs and lice were common. There were few community water systems and even fewer community sewerage systems. The increased mobility provided by roads, canals, steamboats and railroads spread communicable diseases from locality to locality. The increase in world trade and the larger number of ships in American ports from Latin America and Asia brought epidemics of yellow fever and Asiatic cholera.

The first widespread government health measures were regulations to rid communities of nuisances which produced bad odors. Behind this was the theory of miasmata, which held that diseases came from the air by way of bad odors from slaughterhouses, tanneries, decaying vegetable and animal matter, privies, cesspools, duckponds, pigsties and stagnant waters. During the early and middle nineteenth century, many American communities adopted ordinances requiring the removal of filthy and evil-smelling nuisances, or action to make them less foul smelling. These were usually enforced by ordinary police officials, although a few communities established a local health officer or a local board of health (unfortunately with little or no trained personnel). Thus miasmata, a false concept, led to local government measures which inadvertently struck at many of the breeding places of the actual carriers of communicable diseases.

In 1817, there were only 17 community water supply systems in the United States, and 16 of these were owned by private companies. By 1860, 148 communities had public water supply systems, and about 40

per cent of these were owned by city or other local governments. Community sanitary sewerage systems came somewhat later than community water supplies, but beginning around 1850 there was a noticeable increase in such systems. For the most part, the early sewerage and disposal plants, like the community water supply systems, were owned by private companies. Gradually these, like the water systems, were taken over by local governments.

During the 1850's, ideas of environmental sanitation gained headway. Many communities adopted sanitary codes, and such codes were greatly expanded in their coverage. At the same time, a strong movement was afoot to establish a national maritime and quarantine code. Most public health agitation was cut short by the Civil War, but it bore fruit afterward. The concentration of masses of men in the Civil War armies added greatly to the American knowledge of sanitation, "crowd diseases" and nutritional ailments, and emphasized the need for state and local sanitary codes in civilian life.

The most far-reaching advances in public health came slowly in the decades following the Civil War. After 1870, the states increasingly assumed control of the licensing of physicians, raised the standards for practice, and spent larger sums of money on state medical schools. Around 1875 began the "Age of Bacteriology." Scientists in many countries made revolutionary advances in discovering the specific causative agents of communicable diseases and in developing vaccines and antitoxins to immunize against them. State and local sanitary codes multiplied, and state and local health officers and health boards proliferated. However, it was not until 1893 that "states-rights" yielded sufficiently to allow the federal government to assert its authority over port quarantine and begin developing a national maritime and sanitary code.

RAMBUNCTIOUS RIVERS

The United States is blessed with numerous and majestic rivers, but these are turbulent and mischievous. The colorful steamboat era began in the 1820's and reached its height in the 1850's, but at the same time American rivers were alive with flatboats, keelboats, freight barges, and floating log and timber rafts. Disasters to navigation were numerous. Destruction of steamboats by fires and boiler explosions was common. There were frequent collisions, for few flatboats, barges or rafts bothered to keep a lantern burning at night. Steamboats were often wrecked on hidden snags, floating sawyers, reefs and sandbars. When rivers overflowed their banks, steamboats sometimes rammed hidden banks or went over the bank to float atop the swollen waters covering trees and habitations.

Destruction wrought by erosion and floods was frightful. America's rivers had always sliced away at the alluvial banks, but with the cutting of forests accompanying settlement, the erosion of the soil increased. Mark Twain has described how at points where the Mississippi was changing its course (as it sometimes did), the banks would peel off in slices half an acre wide, even tumbling cabins into the river. More calamitous were the seasonal floods, when rivers overflowed their banks for miles on both sides, inundating farmsteads, plantations and towns. At times of great floods, the Mississippi at some places would swell into a vast inland sea 70 miles wide. Some families living along the rivers made it a practice not to flee the floods but instead huddled together with their livestock on flatboats and ate and slept there for weeks, until the waters had receded. Loss of life, damage to property, and injury to health were enormous.

Most remarkable was the way Americans accepted all these disasters as a matter of course. As late as the 1850's, there were no government patrol boats to search for snags, sawyers and sandbars. Dredging service was negligible. There were no locks and dams to help control the flow of water. Mark Twain savagely pointed out that there was not a single buoy or a single lighthouse anywhere along the whole "villainous" Mississippi. The government built no levees, even along the lower Mississippi. Private riparian proprie-

tors made desperate attempts to build their own levees. Later there were combinations of local public and private interests. Then several of the states along the lower Mississippi, notably Louisiana, took some action, operating through local levee districts. But all this was woefully inadequate. Foreign visitors were astonished that Americans carried their fear of government action and their distaste for taxation to such extremes as to suffer these hardships.

Under the interstate commerce clause, the federal government had authority over navigable streams, but the government was slow to act. The first significant federal measures were taken to maintain river channels. At times of low water, channels sometimes became too shallow for safe navigation. There were congressional appropriations in the 1850's for some dredging and scraping of the Mississippi's channel. From 1875 to 1879, under federal authorization, Captain James B. Eads headed a group of engineers who built jetties at the south pass of the Mississippi's mouth, and these resulted in a swifter current and deeper channel there. During the 1870's, too, federal dredging services on major rivers were expanded, and buoys and lights were placed at dangerous locations. Increasingly after the turn of the century, federal locks and dams were built to help supply a sufficient flow of water in navigated rivers.

In 1850, the federal government made a timid beginning toward flood control by granting to certain states along the lower Mississippi some federal lands, the revenues from which were to provide funds to help those states build their own levees. In 1861 and again in 1875, engineering surveys authorized by Congress recommended a system of Mississippi river levees and federal participation, but strict constructionists raised the cry that the Constitution did not permit the federal government to participate in the actual construction of levees. The disastrous flood of 1882 was the turning point, and after that the federal government cooperated with Mississippi river states in the building and maintenance of levees. Through the years the federal government's financial share steadily mounted. In 1928, following the flood of 1927, the federal government enormously increased its appropriations for levees. In the twentieth century, there have been various flood control measures on tributary rivers (the T.V.A. for instance), and these naturally ameliorate conditions on major rivers. Today, the federal government largely maintains the nation's complex river systems of levees, reservoirs, floodways, spillways, distributory channels and locks and dams. Floods are not so much controlled as alleviated.

THE INHOSPITABLE FAR WESTERN FRONTIERS

During the 1860's, 1870's and 1880's, the frontier moving westward was reaching into the high plains of western Dakota, Nebraska and Kansas, and it would eventually meet the mining frontier moving eastward from the Pacific coast. The frontiersmen of the high plains and the western plateaus faced a physical environment different from that of the earlier frontiers. The problem of the earlier frontiers had been a superabundance of nature—trees, water and an overly prolific wildlife. The problem of the far Western frontiers was the niggardliness of nature—the scarcity of trees, water and a wide variety of wildlife. The settlers of the high plains built sod houses, used buffalo chips and corn cobs for fuel, searched frantically for water holes and adequate wells, and were at a loss for fences until the development of barbed wire. They were beset by sudden and blinding blizzards in winter, intense heat in summer, prolonged droughts, dust storms, rapidly spreading and all-consuming prairie fires, and grasshopper plagues, during which a "black cloud" of these insects would descend on a settler's land and within a few hours devour his crops.

Under the Homestead Act, a settler might acquire 160 acres of free land, and this amount was sufficient for a farm family to make a living on lands east of the bend of the Missouri River. But in the dry and treeless West, more land was required to make a

living. The federal government, which exercised more functions after the Civil War, came to the rescue of the Western farmer and rancher. Under the Timber Culture Act of 1873, a homesteader who would plant and maintain 40 acres (later reduced to 10) in trees could obtain title to an additional 160 acres of land. Under the Desert Land Act of 1877, applicable to 11 states and territories in the West, a person might buy 640 acres of public land at the low price of $1.25 an acre, provided he would irrigate at least one-eighth of the land within three years. The Carey Act of 1894 authorized a gift of federal land to Western states on condition that they permit private companies to construct irrigation works upon it and charge settlers for water rights. With the Newlands Act of 1902, the federal government itself went into the business of building the irrigation dams and ditches. Revenues from the sale of federal lands in Western states were set aside for investment in irrigation. A settler might claim as much as 80 acres of federally irrigated land on payment of an irrigation assessment fee of from 20 to 30 dollars per acre. As an encouragement to ranching and "dry farming," the Mondell Act of 1909 allowed homesteaders in certain arid areas of the West to take as many as 320 acres of non-timbered, non-mineral, non-irrigable land.

At the turn of the century there was a growing realization of the extent to which individual enterprise was giving way to corporate capitalism in the United States. The Populists pointed this out; the writers known as "muckrakers" exposed the abuses of the trusts and big business; and the Progressives developed programs to deal with the concentration of wealth and economic power. Among the transgressions of the "malefactors of great wealth" was the way they were said to grab for themselves the forests, mineral wealth and water-power sites of the public domain. The era of widespread homesteading for the little fellow was coming to an end, and he resented the way the Great Barbecue continued for the big fellow, who argued that only big corporations could employ the modern technology required to utilize forests, mineral wealth and water-power sites. Hence the conservation of natural resources came to have a broad popular appeal.

President Theodore Roosevelt (1901–1909) took up the issue of conservation with enthusiasm. During his administration, the United States Forest Service was established to protect the national forests from unlawful cutting and from forest fires, and to undertake reforestation. Gifford Pinchot, the head of this service, thoroughly understood how the destruction of forests was bound up with the problems of soil erosion, the clogging of river channels, and the promotion of floods. During Theodore Roosevelt's administration, some 150 million acres of national forest land were withdrawn from entry and safeguarded from alienation. In 1908, Roosevelt held a White House conference on conservation attended by national, state and territorial officials, by businessmen, and by a number of wide-ranging experts; and he won moral support for such public land policies as protection of the water supply of navigable streams, regulation of the cutting of timber, control of forest fires, reforestation, granting of surface titles to public lands separate from the right to exploit the mineral wealth that lay beneath the surface, and withdrawal from entry of public lands bearing timber, oil, coal, natural gas or phosphate.*

Roosevelt appointed a National Conservation Commission which made an inventory of the nation's natural resources. Near the close of his administration, by executive order he withdrew from entry millions of acres of coal lands, phosphate lands and lands adjacent to water-power sites on the federal domain. About the same time the number of state conservation commissions rose to 41, but it was soon evident that most states were much less able to resist encroachments on their public lands by private interests and to protect the national domain than was the federal government.

After Theodore Roosevelt left office, the drive for conservation was slowed, but it con-

* Ed. note: to prevent settlement and exploitation of resources.

tinued to make gains. In 1909, Congress provided for the separate disposal of the agricultural, timber and mineral wealth of the federal lands. In 1910, Congress created the Bureau of Mines to survey the country's mineral resources and recommend the best methods of their development. In 1920, Congress authorized the permanent retention by the government of all federal lands bearing coal, oil or natural gas. With the growing importance of hydroelectric plants, water power sites on the federal domain were withdrawn from entry, and in 1920 the Federal Water-Power Commission was created and given the right to license and regulate all water power projects that could be reached by federal authority. In 1930, Congress substituted the more effective Federal Power Commission, with regulative responsibilities analogous to those of the Interstate Commerce Commission.

Progress in conservation was not achieved without opposition. Critics charged that American free enterprise was being bridled, that Americans were being "Europeanized." Some asked sarcastically: "Why all this talk about saving our resources for posterity? What has posterity ever done for us?" A number of Westerners claimed that the development of the West was being hampered, that the West's resources were being "locked up," and that the development of the older parts of the country had never been put in a "conservation straight-jacket."

THE NEW DEAL YEARS

The economic depression of the 1930's brought another critical examination of American society and another drive for conservation. President Franklin D. Roosevelt's New Deal carried on a conservation program which was valuable in itself and also created jobs for the unemployed on public projects. The federal government undertook to plant a 100-mile-wide band of trees on the Great Plains from Canada to Mexico to break the force of the winds that blew across the "Dust Bowl." By 1945, around 210,000 acres of shelter belt had been planted.

Also contributing to the husbanding of the country's natural resources was the Civilian Conservation Corps, which operated from camps in all parts of the country. The Corps was composed of young unmarried men who were without employment. These youths, directed by army officers, were set to work cleaning up forests, planting trees, draining ditches, applying anti-erosion techniques and building roads. They lived at the camps at government expense and received modest wages. By the end of 1941, 2,750,000 young men had been on the C.C.C. rolls.

The main purpose of the Soil Conservation Act of 1936 and of the Agricultural Adjustment Act of 1938 was to curtail farm production and raise agricultural prices, and farmers who curtailed production were guaranteed "parity payments" from the federal government. However, in order to be eligible for these payments, farmers were required to limit production of "soil-depleting" crops and to cooperate with the government in an elaborate program for the promotion of soil fertility, the prevention of erosion, and the more economic use of farm land. The more specialized farm agencies of the New Deal—the Resettlement Administration, the Farm Security Administration, and the Soil Conservation Service—were designed to help the poorest and most backward farmers, and all three concerned themselves with instructing such farmers in the basic techniques of scientific agriculture.

In 1933, the federal Tennessee Valley Authority (T.V.A.) was established to contribute to conservation. The Tennessee River and its tributaries flow through seven states and were subject to frequent and devastating floods. The T.V.A. built six giant dams in the Tennessee Valley, and these generated

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William G. Carleton lectures frequently in colleges and universities around the country. He is the author of numerous articles dealing with United States foreign policy and government, and of *The Revolution in American Foreign Policy* (New York: Random House, new edition, 1967).

Where The Water Is*

If optimum use could be made of all the rain that falls on the United States each year, there would be no problem of fresh, drinkable water in the foreseeable future. The average annual precipitation is 30 inches, creating a natural runoff of some 1,200 billion gallons a day.

The precipitation, however, in the form of rain, snow, sleet and hail, varies from less than 4 inches annually in the Southwest to more than 200 inches in the Pacific Northwest. Not only does the precipitation vary from region to region, it also varies from year to year. Flooding and drought exacerbate an already serious problem.

Currently, streamflow provides most of the usable fresh water for the nation—about 67 per cent of our supply comes from this source. This flow supplies domestic water, industrial plants and irrigated farms. The further downstream one taps the water source, of course, the less fresh and drinkable it becomes.

Groundwater, which supplies about 22 per cent of the water in current use, provides the base flow for streams. Groundwater aquifers (the water-bearing beds or strata of permeable rock, sand or gravel capable of yielding considerable quantities of water to wells or springs) will grow in importance as underground reservoirs. The technique of artificial recharge and storage will be increasingly important as streams become more and more degraded in quality.

Not all sections of the country are underlain with water-bearing rock. The gravel, sands, limestone and basalt layers that best hold water in economically accessible amounts and depths form perhaps 10 per cent of the subsurface. The eastern United States has an ample supply of this kind of groundwater, but in many areas, particularly around the Gulf Coast, encroachment of salt water contaminates the fresh water supply.

Aquifers of the Far West are replenished from the alluvial basins which are able to filter large amounts of runoff into deep storage strata. The populous areas of Los Angeles and Phoenix will have to turn increasingly to these sources. Groundwater also exists in the glacial deposits that reach along a northern belt from the Rocky Mountains eastward to the Atlantic.

Some 10 per cent of the groundwater being pumped in the United States comes from the high plains that begin east of the Rockies and run in a long band from South Dakota to Texas. Seven billion gallons a day are taken from this source, and in the southern section the pumping rate greatly exceeds the rate of replenishment.

Recharge or replenishment of these underground sources is a vital requisite for the nation. Each new well drilled upsets the previous balance. Where rapid population growth is taking place, elaborate and highly technical systems must be developed to estimate the desirable or fair distribution of available water.

Floods, which one would suppose to be something of a blessing to water-conscious America, do great harm to our water supply. By silting up the bottom of reservoirs, they greatly reduce the storage capacity of these basins. Where tree cover is washed from hillsides, the water absorptive capacity of the ground is seriously diminished.

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* *Editor's note:* This summary was prepared from material published by the U.S. Water Resources Council under the Water Resources Planning Act of 1965. *The Nation's Water Resources* (Washington, D.C.: U.S. Government Printing Office, 1968).

Noting that "there are crucial limitations on our water supply," this Senator points out that "We must decide that clean water is a necessity and that we are willing to pay for it. . . . The layman must inform himself to be effective in bringing pressure on government, in working toward abatement of water pollution."

Fresh Water: A Diminishing Supply

By Edmund S. Muskie
United States Senate

America's water supply has been the victim of too much optimism. To settlers from Europe and the succeeding generations who pushed the frontier westward, this country seemed vast, its water and other resources limitless. Most Americans believed there would always be abundant water for drinking, for farming, for manufacturing. It was not until the last decade, with Lake Erie already unable to support life and pollution seeping into even the most pristine waterways, that most Americans realized there were crucial limitations on our water supply.

Between 1920 and 1970, the United States' population doubled from 100 million to 200 million, and some experts see our population doubling again in the next 50 years. Meanwhile, the total demand for water has gone up since 1954 from 200 billion to 350 billion gallons a day. There are estimates that this figure will reach at least 500 billion by 1980 and well over 1,000 billion gallons a day by the year 2020. With estimates of the reliable freshwater supply ranging from 650 billion to 1,000 billion gallons a day for that period, it is clear that more and more water must be reused, at a progressively higher cost as the water is taken from dirtier rivers.

Here we see the conflicting demands put on United States rivers, lakes and streams by our highly developed society. These waterways are now required to serve as sewers for municipal and industrial waste and as sources of water for manufacturing and agricultural production. The same "unlimited resources" philosophy which led to the fouling of our domestic waterways now threatens the oceans.

Dr. Max Blumer, a senior scientist at the Woods Hole Oceanographic Institute, warns that pollution of the ocean may be even more irreversible than that of our domestic lakes and streams.

He states:

> Some people believe that, with proper measures, even Lake Erie can be cleaned up in a matter of decades. But the ocean is so big, and its circulation so broad, that it's very likely that any pollution, of whatever degree, is irreversible. Four or five hundred years would be required to balance its effects.

We have taken a significant step in the control of oil spills from tankers or offshore

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Edmund S. Muskie was elected Governor of Maine in 1955 and became United States Senator from Maine in 1959. Among his Senate posts is the chairmanship of the subcommittee on air and water pollution of the Public Works Committee. Senator Muskie was the Democratic candidate for the Vice Presidency in 1968.

"In summary, it appears that if we are willing to initiate and sustain the effort necessary to develop the technology, we have enough fuel for our power needs. . . ."

Power and Fuel Resources

By Robert W. Holcomb
Research Editor, Science, *Washington, D.C.*

For the past 3 decades the consumption of power in the United States has doubled every 10 years, and a number of people believe that this doubling rate is likely to continue to the end of the century. This prospect raises two major questions: Is there enough fuel available to keep up with the projected power demands? If the fuel is available, can it be used without producing completely unacceptable levels of air or water pollution?

Assuming that there are continued improvements in present fission reactors and that fusion reactors are eventually developed, there will be enough fuel for the projected power demands. The gaseous wastes from fossil fuels (coal and oil) and the radioactive wastes from nuclear reactors can probably be controlled with future technical innovations—*if we are willing to put sufficient effort into the development of these techniques.* The possibility that thermal pollution may eventually produce large-scale changes of life on earth, however, remains.

The Office of Coal Research (United States Department of the Interior) estimates that enough fossil fuels can eventually be recovered in the United States to produce 3.92×10^{19} (39.2 million, million, million) British thermal units (B.T.U.'s) of heat. (A ton of fossil fuel can produce about 25 million B.T.U.'s.) Almost three-quarters of this fuel exists in the form of coal. Estimates of how long it will take to exhaust this coal vary greatly, but it has often been said that our fossil fuels can last another 100 years. However, the use of nuclear fuels will be widespread within the next 100 years. Nuclear fuels are used to generate only about 1 per cent of the power in the United States today, but about half the requests for new power generating plants call for the use of nuclear fuels. Thus, by the end of this century perhaps as much as half of the power generated in this country will come from nuclear plants.

The uranium and plutonium fuels used in present fission reactors are not unlimited. The relatively inexpensive ores that are currently being mined are in particularly short supply. However, most scientists believe that it will eventually be possible to build a fusion reactor that uses deuterium—a heavy isotope of the common element hydrogen—as fuel. About 0.015 per cent of the naturally occurring hydrogen is the heavy deuterium isotope and a pound of this fuel can produce more than 100 billion B.T.U.'s of heat. Therefore, one can consider the supply of this fuel almost unlimited.

In the following discussion of the technology that will be utilized to transform our natural fuels into power, we will start with the most distant technology (the fusion reactors), proceed to the intermediate stage (the fission reactors), and end with the current technology (coal furnaces).

FUSION REACTORS

In the late 1940's it was realized that the series of nuclear reactions that fuse deuterium into helium could be initiated if deuterium ions (called a plasma) were held together long enough at sufficiently high temperature and density. It has been believed from the beginning of the controlled fusion effort that the best way to confine the deuterium fuel is with a "bottle" formed by strong magnetic fields. This is possible because the charged particles that are used as fuel are repelled by strong magnetic fields. Several magnetic configurations are possible, and it was assumed in the early days of the program that, if several approaches were tried, continued research would reveal the best.

In the first theoretical models, the plasma was treated as two interpenetrating fluids—one composed of positively charged and the other of negatively charged particles. Devices built on the basis of these models lost their plasmas much more rapidly than the theory had predicted, and subsequent research showed that a number of loss mechanisms (instabilities) were involved. Since the plasma behavior was much more complex than the first theoretical models indicated, it soon became apparent that the research base would have to be broadened to build devices that might not be suitable for the ultimate fusion system but that would enable researchers to study plasma behavior.

The project might have been dropped when the full extent of the difficulties was realized, but the advantages of controlled fusion over other methods of generating power were too great. In addition to the almost unlimited supply of deuterium, there would be few toxic or radioactive waste products, and there would never be enough deuterium present in the devices for a runaway reaction. Looking well into the future, physicists even saw the possibility of converting directly from nuclear to electrical energy without the intermediate production of heat.

So the research teams built devices to study the complexities they had discovered. According to the scheme of classification used by Amasa Bishop, assistant director (for controlled thermonuclear research) at the Atomic Energy Commission (A.E.C.), there are now 115 major plasma devices in the world, and they utilize 16 different types of magnetic configurations. Most plasma physicists would say that no more than six of these have any chance of being developed into an operational device.

In the United States program, there are four major fusion laboratories: Oak Ridge National Laboratory (Tennessee), Princeton Plasma Physics Laboratory (New Jersey), Los Alamos Scientific Laboratory (New Mexico), and Lawrence Radiation Laboratory (California). In addition, about 40 universities, several private laboratories and several government laboratories have small programs. Each of the major laboratories tends to concentrate on only a few types of devices, and each has a special competence with at least one type that might eventually be developed into an operational model.

No plasma device anywhere in the world has been developed to the point where it could sustain a controlled fusion reaction that would be useful for power production, but the general consensus among plasma physicists is that the program in the Soviet Union is the most advanced—especially the Soviet work on a series of devices known as *Tokamaks*. The Soviet lead in the fusion program is not the result of simply having stumbled onto a good magnetic configuration. The Soviets spend about twice as much money and employ about three times as many people in controlled fusion research as does the United States. Although they direct a large fraction of their effort toward *Tokamaks*, they have a high caliber program in most other areas.

It is difficult to say when (or even if) controlled fusion will become useful for large-scale power production. Even if a successful magnetic configuration—or some other confinement system—were discovered tomorrow, the engineering and development requirements of this type of technology are such that it would be the end of the century before the system could generate a significant fraction of the world's power.

As is well known, there are already many fission reactors producing power in the United States. What is less well known is that the current reactors are extremely wasteful of fuel.

The fuel in fission reactors is some element that will split apart when struck by a particle —usually a neutron—and release some of its nuclear energy. If the neutron is traveling fast, one kind of reaction can take place and if it is moving slowly, another reaction can take place (provided that the proper fuels are present). With fast neutrons it is theoretically possible (but technically difficult) to develop schemes in which fuel that is now wasted can be used. These schemes—when put on a large power production scale—are known as breeder reactors. The rate at which uranium reserves are used will depend on progress in the breeder reactor program and on our willingness to use expensive (hard to recover) ore deposits.

The fuel rods in the light water reactors now in use contain uranium-238 and small amounts of uranium-235 and plutonium-239, but only the last two isotopes are utilized as fuel. Uranium-238 can be used as fuel if it is converted to plutonium-239 by the capture of a fast neutron, but the fast neutrons in light water reactors are slowed down by the water coolant, and no significant amounts of plutonium-239 are produced. In the most promising types of breeder reactors, liquid sodium or fused fluoride salt coolants would be used and the concentration of fast neutrons should be so high that more fuel is produced than is consumed.

The A.E.C. estimates that full-scale commercial use of breeder reactors will be achieved by the mid-1980's. Several observers in the coal industry and in academic and consulting positions believe that this is a very optimistic estimate, but few doubt that most of the country's nuclear power will eventually be generated by breeder reactors.

The time required for the development of breeder reactors is important because they require fuels with some uranium-235, and the supply of inexpensive ores containing this isotope is limited. If reactor development proceeds as the A.E.C. expects, the inexpensive reserves of uranium (less than $10 per pound of U_3O_8)[2] will be used up in the mid-1980's—the same time that the A.E.C. estimates that breeder reactors will come into use. Medium-priced fuel (up to $30 per pound of U_3O_8) will be exhausted between 1990 and 2000, the rapid development of breeder reactors delaying the time by a few years. With breeder reactors, the use of new reserves would level off around the turn of the century, after more than 1 million tons of U_3O_8 had been consumed. Without breeder reactors we would begin using up the 10 million tons of known reserves a few decades after the year 2000. The often-heard criticism that the A.E.C. is pushing the development of the current generation of light water reactors too fast is based on the fear that these inefficient devices will deplete the supplies of inexpensive and medium-priced uranium.

Although the construction of just about every nuclear power generator that has been proposed to date has been opposed by some kind of conservation or citizens' group, most people in the power industry—including those who work exclusively with coal—agree that nuclear power plants do not pose as much of a pollution threat as fossil fuel plants. For example, a coal plant operating under existing regulations releases more radioactive material into the atmosphere than a nuclear plant of the same capacity. (The radioactive isotopes are found naturally in the coal.) In addition, of course, coal plants release gases and solid wastes.

DISPOSAL OF WASTES

The following scheme has been developed by the A.E.C. to take care of waste products from nuclear reactors. These wastes are in the form of gases, liquids, and solids. Gases are formed during the nuclear reaction and are released to the atmosphere through stacks. The water that is used in the reactor —mostly for cooling—becomes radioactive by dissolving radioactive corrosion products. Most solid waste consists of spent fuel rods.

[2] Uranium oxide.

Relatively simple techniques could be used to precipitate most of the radioactive waste in the water, and it could be added to the solid waste. Present plans call for the solid wastes to be stored for 150 days at the reactor site where radioactivity will be reduced by a factor of 30. The solids will then be shipped to fuel reprocessing plants (which handle solids from about 50 reactors) where they will be treated and stored for 10 years before being shipped to a repository. The A.E.C. estimates that, by the end of the century, 800,000 cubic feet of solid waste will require 700 acres of abandoned salt mines for storage.

Krypton-85 is released to the atmosphere at both the reactor site and the reprocessing plant. The methods required to trap krypton (such as cooling to extremely low temperatures) are not simple, but the basic technology is known. Obviously we cannot continue to release this gas into the atmosphere as more and more nuclear generators are put into operation, so the main problems are to determine acceptable levels of krypton addition and to have the technology available for containing it when this is necessary.

Tritium is another heavy isotope of hydrogen, and it is formed from lithium and boron in the cooling water. It thereafter combines with oxygen to form a heavy isotope of water. At the reactor site it becomes part of the water that is released to nearby streams or lakes, and in the reprocessing plants it is released to the atmosphere as water vapor. In both cases it is extremely difficult to remove, and the A.E.C. is currently considering plans to store some 200,000 gallons of tritium-bearing water each year in deep-well injection facilities. As part of a water molecule, tritium could become incorporated into tissues of living plants and animals. As in the case of krypton, the main problem is to determine when the tritium must be stored rather than released to the environment.

There are a few people who believe that the plans developed by the A.E.C. to dispose of radioactive wastes from nuclear reactors do not offer adequate protection to the environment and to the public. However, most scientists who have studied the problem agree that if provisions are later made to capture the krypton-85 and tritium that is now released to the environment, then the shipping and storage of radioactive wastes will pose no greater threat to our well-being than the procedures now used to produce power from fossil fuels.

Even if this is the case, two questions remain. There is a remote possibility that the storage sites could be severely disrupted by an earthquake, thus exposing a large area to radiation for a long period of time. No catastrophe of this magnitude is possible with present power production techniques, so one can ask: Should we take the chance of allowing even this remotely possible accident to occur?

Second is the question of the burden for our descendants. The large storage areas of radioactive wastes will remain radioactive—and hence potentially dangerous—for hundreds of years. (As time passes more and more radioactive elements decay into harmless, stable elements, but even after thousands of years some of the radioactivity remains.) Do we want to leave a radioactive "garbage pile" for our descendants?

FOSSIL FUEL POWER

All fossil fuel power plants now in operation pollute the environment. Inherent in their operation is the release of heat either to the atmosphere or to natural bodies of water and the release of carbon dioxide to the atmosphere. In addition they add solid wastes and many gases—the most harmful being sulfur dioxide—to the atmosphere. Since we will still be generating half or more of our power by fossil fuel plants at the end of the century, it is vitally important to devise means of correcting the polluting processes that we are now using.

Laws limiting the sulfur content in fossil fuels have been passed and more are expected. These laws, however, do nothing to provide low-sulfur fuels or to develop methods of trapping the sulfur in present fuels. Short-term plans are to use more natural gas (which is the least plentiful of all fossil fuels) and foreign oil and liquid gas. When these

low-sulfur fuels are exhausted, sulfur control will depend on the development of new methods of trapping sulfur and new methods of burning coal with a high sulfur content.

All large coal-burning power plants in the United States use the pulverized fuel technique in which powdered coal is blown into furnaces with very large volumes. This method produces much particulate matter and leaves the waste gases in an oxidized state in a large volume of air. The particulate matter can be collected with electrostatic precipitators. These utilize well-established technology, but they are usually larger than the furnace and are expensive to install. For example, the precipitator for the 1000-megawatt plant at Ravenswood, New York, cost $10 million.

The search for an economic method of collecting the sulfur from pulverized-fuel combustion has been going on for 30 years, but there are still no efficient devices for collecting sulfur in any large power plants now in operation. Some observers believe that with either economic incentives or laws setting lower limits on sulfur emission the power companies would develop effective sulfur controlling devices within a few years. Others believe that there are difficult technological problems to overcome and that there is no technique on the horizon that seems to have the potential for rapid development.

As long as sulfur is spread through a large volume of air and occurs in the form of sulfur dioxide—conditions inherent in pulverized-fuel combustion—sulfur removal methods will be difficult to develop. However, as early as 1922 a method of pulsing air and steam to burn coal (the fluidized-bed technique) had been developed in Germany. In the mid-1950's, Albert Godel in France modified the method so that it was applicable to the large furnaces required for modern power production. The British are working on fluidized-bed techniques at pressures up to 15 atmospheres. The first fluidized-bed generator to be built in the United States will be a 275-megawatt plant constructed in the Wilkes-Barre–Scranton area of Pennsylvania.

It should be possible to combine several features of the different fluidized-bed burners that have been developed in such a way that the sulfur would be released as hydrogen sulfide in a small volume of air. This would require the development of techniques for extracting the sulfur under pressure, but this difficulty would be outweighed by the advantage of having the sulfur in its reduced form in the much smaller volume—a condition that would make chemical extraction much easier.

Somewhere between the short-term improvements in fossil fuel power production—sulfur control techniques and pulverized-bed techniques—and the longer-term development of breeder reactors is the technology of magnetohydrodynamics. This method of power production relies on the fact that when a charged particle is passed through a magnetic field an electric current is produced. This is a more direct conversion of the fuel into power, and when developed it will be possible to generate electricity with about 50 per cent more heat efficiency and virtually to eliminate sulfur emission. These objectives, however, can only be met if methods of processing fuels are developed along with the magnetohydrodynamics.

It is difficult to predict when any of the improved fossil fuel techniques will go into operation. A number of people have argued that if we had put the effort into the development of these techniques that we are putting into the development of controlled fusion and into fission reactors (or landing a man on the moon), we could have nonpolluting coal-generated power now. If this is the case, then it is technically possible to have the methods developed within the next few years and operating within decades, but there are no indications that we have started to make the necessary effort. All sulfur control and coal combustion research in the United States is financed with a few million dollars per year; such research has not increased significantly over the past few years and has received no indication of significant increases in the future. Therefore, we may continue to pollute the environment until

nuclear reactors begin generating a significant fraction of the world's power.

OTHER POLLUTION

The extraction and transportation of fossil fuels also contribute to the degradation of the environment. Mining of coal—especially strip mining—leaves thousands of acres of land scarred, and water draining through abandoned mines becomes acidic and pollutes local water. Although there is need for more research on acid mine water, most of the environmental problems associated with mining could be solved today if sufficient effort were directed toward the problem. This is, after all, essentially nothing more than a large-scale landscaping process.

Coal companies generally do not calculate land renewal and acid mine water drainage control in their production costs, so it is probably not possible to have them improve areas that have already been mined. These areas could be improved with federal support and legislation could be passed that would make it possible to clean up future mining areas as they are mined.

A more difficult problem associated with the extraction and transportation of fossil fuels was introduced by the use of oil. In 1966, 700 million tons of oil—about half the world's total ocean tonnage—were shipped in 3,281 tankers. In the best of all worlds, this oil would remain in that part of the "ecological" system of interest only to humans—wells, tankers, refineries and, finally, furnaces and machines. It is difficult to estimate just how far short we are of living in the best of all worlds, but between 1 million and 100 million tons of oil are added to our oceans each year.

The major sources of this oil pollution are handling errors, leaks from natural deposits, tanker and barge accidents, and illegal tanker bilge washings. Normal techniques of transferring oil to small coastal tankers, barges and shore facilities result in a chronic source of coastal oil. The total amount of oil from this source is unknown, but the Massachusetts Division of Natural Resources says that in Boston Harbor alone a spill involving several tons of oil can be expected every third week. Less frequent, but more spectacular, are leaks from offshore deposits. These can occur naturally, but they have been associated with drilling operations since the 1930's, when fields in the Gulf of Mexico were opened. The biggest loss associated with the more than 9,000 offshore wells was the million-gallon blowout early in 1969 off the California coast near Santa Barbara. Tanker accidents are similar to well blowouts in that an occasional major catastrophe highlights a constant source of contamination. The grounding of the *Torrey Canyon* off the southwest coast of England in March, 1967, was simply the most dramatic example of a type of accident that, on a world-wide basis, occurs more than once a week. Finally, deliberate dumping of bilge washings adds a considerable but unknown amount of oil to the oceanic environment. In 1962, Shell Oil Company developed a method to separate oil from such washings, and there is a tacit international agreement to use the method. However, shipmasters find the procedure inconvenient, and the dumping practice continues.

Although our oil resources are not unlimited, a quick look at the future indicates that pumping and shipping operations will continue to expand for the next few decades. The continental shelves of North and South America, Africa and Australia all have oil. Seismic profiling has indicated the probable presence of oil in the North Sea, the Persian Gulf and Indonesia, and large deposits have been discovered in Alaska and Canada.

Oil from these new sources will be transported through pipelines and by gigantic tankers. Construction has already begun on a road that will be used to build the 800-mile, 48-inch, $900-million pipeline from Alaska's North Slope to Valdez Bay, an ice-free port on the Gulf of Alaska. The large United States merchant vessel *Manhattan* was specially strengthened for travel in ice and fought her way through the Canadian Arctic in September, 1969. On the basis of this trial run—and in spite of the fact that ice ripped a hole in the *Manhattan*—plans

have been made for a fleet of six, quarter-million-ton vessels for year-round service. (The *Torrey Canyon,* considered a large ship at the time of her grounding, had a displacement of 127,000 tons.)

The proposed drilling activities will involve greater risks of major losses because work must be done at sea or in inhospitable northern latitudes. The use of large tankers will reduce the probability of collisions and groundings, but there are few port facilities for these giants, so the possibility of spills during transfers to smaller tankers or barges will be increased. Major accidents, of course, will be of colossal proportions.

In case of oil spills, present alternatives are (1) to "corral" the oil and hold it at sea, (2) to pick it up mechanically, or (3) to treat it chemically so it will emulsify, dissolve, or sink. None of these methods is particularly successful, and research on all of them is continuing. The major requirement for further development is engineering and chemical knowledge, but some biological knowledge is necessary because some of the techniques are harmful to living systems.

HEAT BALANCE

Fifty per cent or more of the energy produced by power plants now in operation goes to the environment as waste heat, and even the most efficient generators envisioned for the next few decades will be no more than 75 per cent efficient. Even most of the electricity produced eventually finds its way back to the environment as heat. In addition, all fossil fuel plants potentially add to the earth's heat balance by producing carbon dioxide that absorbs energy by a process known as the greenhouse effect.

In the greenhouse effect, energy from the sun passes through the atmosphere and is absorbed on the earth's surface. The energy is reradiated at longer wave lengths that can be absorbed by water and carbon dioxide in the atmosphere. Theoretically, if more carbon dioxide is present, less heat will be radiated out to space and the entire earth will heat up. This has not yet been established by observation. Calculations show that a 10 per cent increase in the total carbon dioxide content would cause an increase of 0.2° centigrade in the average temperature; doubling the carbon dioxide content would produce an increase of 2.5° centigrade. (If we burned all our fossil fuels that are thought to be economically recoverable, it would double the carbon dioxide content of the atmosphere.) At the present time the total carbon dioxide content is being increased about 0.06 per cent per year by the combustion of fossil fuels, but during the past 25 years—when the human addition of carbon dioxide has been most rapid—the average temperature has decreased 0.2° centigrade. (Other climatic changes not reflected in average temperature could have occurred.)

The indirect effect of carbon dioxide addition is reinforced by the direct addition of heat from power plants. Current steam boilers lose a little more than 60 per cent of their energy to the environment as heat. Gas turbine boilers with efficiencies of about 50 per cent are possible within the next decade. Light water reactors now in use are only about 30 per cent efficient. Very little of their waste heat can be added to the atmosphere, so these facilities require large volumes of water. Breeder reactors are expected to be about 40 per cent efficient. There are no technological innovations in sight that will be able to reduce heat losses much more than magnetohydrodynamic processes.

It is estimated that by 1980 one-sixth of the freshwater runoff in the United States will be used to cool power plants and that by the end of the century the figure will have increased to one-third. Because of the large spring runoff, greater fractions of the flowing water are used for most of the year. For example, in 1980 one-half of the water will be needed for three-fourths of the year.

(*Continued on page 365*)

Robert W. Holcomb taught courses in chemistry and then turned to science writing. He worked at the American Institute of Physics in New York, then joined the staff of the American Association for the Advancement of Science.

Evaluating the nation's arable lands, this specialist notes that "there appears to be sufficient arable land in the United States to meet food and fiber requirements for the next 40 to 50 years. This conclusion seems valid to the extent that we accept our historical value system, our traditional consumption patterns, and our projected assumptions about land productivity."

A Census of Arable Lands

By Ray Lanier
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There are about 2.3 billion acres of land in the United States and Puerto Rico. Of this, over 700 million acres were under the management of several federal agencies in 1960–1965. A large portion of this acreage under federal management is in Alaska and the Western states. Non-agricultural land in 1960 amounted to 177 million acres in conterminous United States. Thus, as shown in Table 1, nearly 1.5 billion acres of land in the 50 states are non-federal and non-urban. Of that total, 800 million acres have been classed as suitable for regular or intermittent cultivation and over 600 million acres as not suitable for "ordinary" cultivation. What does this mean in terms of "arable" land?

The *Journal of Soil and Water Conservation* defines arable land as "areas of land so located that production of cultivated crops is economical and practical."[1] Underlying this definition is the notion that arable land is that land which has a particular relationship to man, land which man views as being cultivated in a practical or economic manner. Any piece of land might be arable—more or less—depending on the factors making for its economic use at any particular time. The term "economic" depends in part on the changing nature of the sum of men's desires for various goods and the way in which men organize their efforts to meet these desires. To this extent, "arable" land is a subjective term, depending for definition in part on the value system of the beholder.

Our discussion of the implication of the definition in terms of the present and future amount and use of arable land in the United States will begin with an examination of some aspects of the definition. A look at the tables will tell us about the present use of arable land and about the future uses of land under certain conditions. We will mention attributes of arable land which man might control. Lastly, we will draw some conclusions about arable land constraints in the future.

Three fundamental elements are contained in the definition of arable land; it is land which:

1) has been historically tilled or cultivated;
2) is practical to till;
3) is economical to till.

Each of these three elements is some function of the social values and goals of the times. Land was cultivated historically because society provided incentives to the tiller to use the land to provide goods wanted by himself and others. The incentives operated through the economic system in a manner which made it economic to till the land. It may be useful to review the characteristics

[1] January–February, 1970, p. 5-G.

TABLE 1.—LAND CAPABILITY CLASSES BY LAND USE FOR 50 STATES FOR NON-FEDERAL NONURBAN LAND[1]

(In thousands of acres)

Class[3]	Cropland	Pasture & range	Forest & woodland	Other	Total
Suitable for regular cultivation:					
I	27,435	3,940	3,573	1,247	36,195
II	192,923	42,851	43,426	11,279	290,479
III	152,970	66,602	77,910	13,854	311,335
Subtotal I–III	373,328	113,393	124,909	26,380	638,009
Suitable for intermittent cultivation:					
IV	48,993	53,938	58,413	7,838	169,181
Subtotal I–IV	422,321	167,330	183,322	34,218	807,190
Not suitable for ordinary cultivation:					
V	1,773	10,525	28,920	1,832	43,051
VI	17,940	166,288	88,490	4,995	277,712
VII	5,636	138,690	144,227	7,682	296,233
VIII	66	2,523	6,518	18,136	27,242
Subtotal V–VIII	25,415	318,025	268,154	32,645	644,238
Total[2]	447,736	485,356	451,476	66,863	1,451,428

[1] Estimates from the National Inventory of Soil and Water Conservation Needs made as of 1958. Because of rounding to thousands, the total of items listed may not coincide with the total shown.

[2] Does not include 1,445,000 acres of unclassified land.

[3] The Land Capability classification of the United States Department of Agriculture is used to represent a practical grouping of soils which, considered with climate, can influence their use, management and production in a farming situation.

which make for an economic condition.

We can say it is economical to use land in a certain way if there is a market for the products from that land. A market consists of at least two parties: someone who is ready and willing to sell and someone who is ready and willing to buy. A transaction will take place if the supplier can be induced to part with his good at a price which will cover his costs, as he sees them; that price being one which the buyer believes represents the usefulness of the product to him, considering all his alternatives. This would be the "market clearing" price. To define economical in any particular instance, then, we must determine the cost of production and the amounts that would be consumed at that price; i.e., the supply and demand function.

This elementary relationship between buyer and seller is critical to an understanding of the way in which a change in social values interacts with the economic criterion to define arable land. There is social significance in this concept of seller and buyer interaction to set a price which will determine the amount of products that will be produced and purchased. At any particular market-clearing price, we should expect that the amount of land used in production will be that for which the cost of all factors of production will be equal to or less than the price. If the costs of land and other resources in production are greater than that price, the entrepreneur cannot operate economically.

By the same token, at any market clearing price, some members of society may not be able to enter the market. They may not have enough money to pay the price of the product and must do without or substitute some less costly good. The numbers of people excluded in the United States may vary from time to time and from product to product. However, recent public discussion suggests that upwards of 10 million people in this country may be effectively excluded from the market for many necessities.

It should be clear that the economic criterion is an optimizing behavior which, in our socio-economic system, maximizes private profit with the constraint that each member of society participates to a certain minimum extent. A different socio-economic system

TABLE 2.—TRENDS IN MAJOR LAND USES, CONTERMINOUS UNITED STATES, 1900–1965

(Million acres)

Land Use	1900	1920	1940	1960	1965
Cropland[1]	389	480	467	458	444
Pasture & Range[2]	761	652	650	630	636
Forest[3]	610	614	630	637	638
Total Agricultural Land	1,760	1,746	1,747	1,725	1,718
Nonagricultural Land[4]	142	156	155	177	184

[1] Cropland harvested, crop failure, cropland idle or fallow, and cropland used for pasture.
[2] Grassland pasture and other nonforested grazing land.
[3] Includes grazed forest land and reserved forest lands.
[4] Includes special land uses, such as urban areas, highways and roads, and parks.

might have different optimizing criteria. Either case might affect the economic criterion differently and thus change the measured amount of arable land. If society's objectives change, as indicated by the recent Presidential position on the welfare program, then the need to redefine arable land may also change. By consumer subsidy or other means, we may decide to bring land which presently may not meet the economic criterion into the economic sphere. There may be social benefits to offset the additional costs.

ECONOMICS OF LAND USE

Among the factors important in determining the economics of the use of arable land are:

1) The demands for the products of land;
2) The change in future demand considering the changing costs of production, the increasing scarcity of resources, and changing consumer values;
3) The changes in technology of production.

The present and future relationship of these factors and the land resource may be indicated by the results of recent reports. Studies in the use and availability of water and related land resources are being conducted across the country by cooperating groups of federal, state and local agencies, under the aegis of the Water Resources Council. Some preliminary conclusions about the future arable land in the United States may be drawn from the "First National Assessment of the Water Resources Council"[2] and from several regional studies recently completed or under way.

FUTURE USE

The historical use of land in the United States and the 1960 distribution of its use are shown in Tables 2 and 3. These may be compared with Table 4 which shows the distribution of non-federal rural land considered suitable for cultivation. The slight differences in totals between Tables 1 and 4, which might be due to differences in regional detail, need not distract from the main conclusions. About 25 million acres of land now being used for production are classed as not suitable for ordinary cultivation. However, about 75 million acres of the land "not suitable for ordinary cultivation" would become so with major reclamation projects.

Only future demand and technological advance can tell us how much of the over 600 million acres classed as outside ordinary cultivation practices society might ultimately cultivate. Table 5 provides an index of projected output of agricultural products which might be required for a population of 467 million people by the year 2020. In Table 6 is the estimate of land use which would provide for that future level of demands, given the consumption and production estimates used by the Water Resources Council. Approximately 41 million acres of cropland could be expected to be in an idle or fallow category as late as the year 2020.

[2] *The Nation's Water Resources* (Washington, D. C.: U. S. Government Printing Office, 1968), Library of Congress Catalogue Card No. 68-62779.

TABLE 3.—LAND USE, CONTERMINOUS UNITED STATES 1960[1]

(Millions of acres)

Region[4]	Total land base	Cropland			Pasture and range	Forest	Non-agricultural land
		Total	Used for crops[2]	Idle and fallow[3]			
North Atlantic	106.3	17.6	15.4	2.2	8.0	66.7	13.9
South Atlantic-Gulf	167.2	29.6	24.3	5.3	16.7	108.9	12.0
Great Lakes	82.3	26.8	22.6	4.2	4.8	39.6	11.2
Ohio	102.2	39.3	34.8	4.5	12.5	40.2	10.2
Tennessee	27.3	6.5	5.4	1.1	2.7	16.4	1.7
Upper Mississippi	112.0	65.3	61.5	3.7	12.4	24.3	10.1
Lower Mississippi	41.7	14.8	13.1	1.7	3.5	17.7	5.6
Souris-Red-Rainy	33.5	20.5	15.0	5.5	4.1	6.1	2.9
Missouri	329.4	115.1	88.0	27.1	166.8	31.4	16.1
Arkansas-White-Red	170.4	51.0	38.8	12.1	59.4	45.0	15.1
Texas-Gulf	117.6	28.5	24.1	4.4	55.6	25.1	8.4
Rio Grande	87.5	2.8	2.2	0.6	59.7	14.1	10.9
Upper Colorado	65.0	2.0	1.7	0.3	32.2	22.3	8.5
Lower Colorado	98.8	1.8	1.4	0.4	57.8	28.6	10.6
Great Basin	87.2	2.9	2.1	0.7	57.0	20.9	6.4
Columbia-North Pacific	169.3	19.5	13.8	5.7	54.1	84.5	11.3
California	104.0	13.6	11.3	2.3	22.9	45.4	22.1
Conterminous United States	1901.8	457.5	375.5	82.0	630.1	637.3	176.9

[1] Values rounded.
[2] Includes cropland harvested and cropland used for pasture.
[3] Includes soil improvement crops and crop failure.
[4] Water Resources Regions of the United States as defined by the Water Resources Council.

While the data available here suggest that the arable land resource is adequate for the foreseeable future, many factors can and do affect the conditions that will exist. These factors may be classified as those which affect commodity demand and the technology in supply of food and fiber and those factors which affect the availability of land for food and fiber.

An obvious and major factor affecting demand is the size of the population. The land use projected in Table 6 is based on consumption associated with a population size which some authorities might consider high. Since those original projections were published, much has been said about the potential for new birth control techniques. Some students suggest that a national policy aimed at a static population is desirable and feasible. It is evident that a change in social values in favor of a stable population would relieve pressure on arable land.

On the other hand, a shift of values in favor of including all of the population in a market for food and fiber would tend to increase the pressure on land. Changes in consumer preferences could affect land use. A substitution of seafood for products of the land would release land for other uses while a desire for land-intensive products would have the contrary effect. The export/import relationships for food and fiber affect the rate at which national goods, including land, become scarce.

Congressional discussions of the National Environmental Policy Act of 1969 emphasized the fact that society is placing increasing importance on improved quality in the environment. This tends to shift the national consumption patterns in favor of aesthetic "goods" relative to other material consumption goods. In the future, some land might be set aside for environmental values. Zoning or other controls might be used to control shifts of land from agrarian uses.

Technological developments can have a

TABLE 4.—LAND SUITABLE FOR CULTIVATION, NON-FEDERAL RURAL LAND

(Millions of acres)

Region	Suitable for regular cultivation	Suitable for limited cultivation	Suitable for cultivation with major reclamation projects only	Total potentially suitable for cultivation	Total non-federal rural land
North Atlantic	34.4	9.7	0.5	44.6	96.6
South Atlantic-Gulf	77.4	29.9	13.3	120.6	152.3
Great Lakes	44.4	10.3	0.9	55.6	65.7
Ohio	48.8	9.6	0.3	58.7	94.6
Tennessee	9.0	3.3	–	12.3	23.7
Upper Mississippi	74.9	12.7	3.3	90.9	105.3
Lower Mississippi	22.5	3.7	3.5	29.7	37.9
Souris-Red-Rainy	25.4	4.4	2.2	32.0	36.0
Missouri	119.0	34.5	3.1	156.6	278.1
Arkansas-White-Red	72.8	17.3	6.6	96.7	156.4
Texas-Gulf	62.6	11.4	6.1	80.1	112.7
Rio Grande	4.8	2.7	7.6	15.1	64.0
Upper Colorado	1.5	1.8	1.6	4.9	21.6
Lower Colorado	1.7	0.3	19.3	21.3	46.6
Great Basin	3.2	0.9	1.7	5.8	21.0
Columbia-North Pacific	21.7	9.8	1.9	33.4	80.4
California	14.0	6.3	3.1	23.4	54.7
Alaska	0.6	0.2	n.a.	0.8	1.3
Hawaii	0.3	0.3	0.4	1.0	3.5
Puerto Rico	0.4	0.3	n.a.	0.7	2.0
Total	639.4	169.4	75.4	884.2	1,454.4

great impact on the requirement for arable land to meet food and fiber production needs. Changes in technology which improve crop yields and livestock feed efficiencies can affect the economics and practicality of cultivating the several classes of land. Constraints in the use of technology are also possible. Increasing public understanding of and emphasis on environmental values may restrict the use of certain technical developments or, more likely, may induce research into more effective and acceptable alternative production techniques.

WATER RESOURCES STUDY

Water resource studies provide information on the ways that investments in that program might increase the amount and productivity of arable land. There are 75 million acres of land (Table 4) now unsuitable for cultivation which would be practical to till after major reclamation projects. Major drainage and flood protection projects might bring more land into cultivation or increase the productivity of land which is currently arable.

The increasing urban and industrial population has resulted in a shift of land out of production for food and fiber. (See Tables 2 and 6.)

Moreover, there is some indication that a proportionately large amount of highly productive land is being directed to such uses. This trend might be partially controlled by zoning land use with future social demands in mind.

At this point, there appears to be sufficient arable land in the United States to meet food and fiber requirements for the next 40 to 50 years. This conclusion seems valid to

TABLE 5.—PROJECTIONS OF AGRICULTURAL AND FORESTRY OUTPUT BY MAJOR PRODUCT GROUPS

Product group	Base[1]	Projections		
		1980	2000	2020
		Index numbers		
Feed crops	100	140	182	234
Food crops	100	150	196	261
Oil & fiber crops	100	144	182	235
Livestock & livestock products	100	142	196	273
Industrial timber products	100	124	150	165
Pulpwood	100	188	308	341

[1] For agricultural products, 1959–61 = 100, and for forest products 1962 = 100.

the extent that we accept our historical value system, our traditional consumption patterns, and our projected assumptions about land productivity. Our value system may change in ways which tend to relieve pressure on arable land. Recent discussions on stable population objectives provide one example of such potential changes. Changes in social values represented by minimum income concepts and environmental quality objectives may also call for more competition in use of arable land.

The increasing complexity of society calls for greater sophistication in analyzing land-use alternatives in terms of changing social values and objectives.

TABLE 6.—PROJECTED LAND USE, CONTERMINOUS UNITED STATES, 1960–2020

(Million of acres)

	1960	1980	2000	2020
Cropland	458	425	416	408
Used for crops	(376)	(336)	(343)	(367)
Idle & fallow	(82)	(89)	(73)	(41)
Permanent pasture	630	649	642	650
Forest & woodland	637	621	602	563
Non-agricultural	177	207	242	281
Total	1,902	1,902	1,902	1,902

Notes on Sources

The studies undertaken by state and federal agencies cooperating through the Water Resources Council offer much information on land use and the pressure on land. See for example:

Upper Mississippi River Comprehensive Basin Study, Appendix N, Agriculture, prepared under supervision of UMRB Coordinating Committee by United States Department of Agriculture, 1969 (Draft No. 32 referred to here).

The Nation's Water Resources. The First National Assessment of the Water Resources Council, United States Water Resources Council, Washington, D. C., 1968. Parts 1–7. Library of Congress Catalogue No. 68-62779. (This was the source for tables 2 through 6.)

An authoritative source on agricultural products from which Table 1 was obtained is:

Food and Fiber for the Future, Report of the National Advisory Commission on Food and Fiber (Washington, D. C.: U. S. Government Printing Office, July, 1967).

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"Securing an adequate resource of forest wilderness is one of the challenges facing the nation." In the 1970's, "the relationship of forest trees to man and his survival is becoming evident."

Forest Lands and Wilderness

By Michael Frome
Conservation Editor, Field and Stream

Forests even now cover an estimated one-third of the land area of the United States. As sources of raw material, they play a significant part in the physical standards of American life. As conservers of soil and water, they are absolutely necessary if we are not willing to have our country become as denuded and flood-swept as the Chinese hillsides and valleys. As environment for the highest type of recreational and aesthetic enjoyment, including wilderness vestiges of the original America, they are essential to the happiness of millions of human beings.

In our modern age, forests serve as barriers to hot polluted air and restore the atmosphere with volumes of oxygenated air. In urban areas, they reduce harsh sounds and the effects of solar radiation, and limit the movement of wind, dust and snow. Economic, physical and social considerations demand that we maintain a bountiful forest resource. Yet the prolonged failure to protect and enhance these forests—based on the responsibility rather than right of land ownership—has contributed directly to the environmental crisis we face today.

Gifford Pinchot, the father of modern conservation and scientific forestry in the United States, made this plain. "The earth," he wrote, "belongs by right to all its people and not to a minority, insignificant in number but tremendous in wealth and power." Thus he saw forest management as a social issue. "The rightful use and purpose of our natural resources," he said, "is to make all the people strong and well, able and wise, well taught, well fed, well clothed and well housed, with equal opportunity and special privilege for none."

Pinchot strongly advocated government regulation over privately owned forests, the need for which becomes increasingly apparent with the passage of years. When the first European settlers arrived, there was no such urgency. Forests covered 800,000,000 acres of the continental United States, and the land was dense and dark with trees. The early pioneers might have known better than to indulge in waste and despoliation, considering that forests were no luxury in Europe and were already being managed with an eye toward perpetual yield. Or they could have learned from the Indians, many of whom practiced a form of conservation by taking no more than they needed.

Trees were useful, but barred the way of farms, homes, cities. The more felled, or burned, the better; there would always be more—such was the philosophy from colonial days to the latter part of the nineteenth century. True, there were a few early restraints. The British government, for example, reserved for the use of its navy a future supply of the great white pines of Maine. But essentially, as long as forests and timber seemed limitless, concern and caution had no place in the scheme of things.

Maine was the first chief lumber source, supplying markets of the Atlantic Seaboard for more than two centuries; but by 1850 it showed the results of unrestrained exploitation. Then, for ten years, New York came to the forefront, followed by Pennsylvania, with its choice hardwoods and pines. Timber demands increased as the frontiers pushed westward. During the 1850's, prairie schooners and canalboats were made of wood, and railroads were laid on wooden ties. After the Civil War, there were new industries, new cities, new homes, all utilizing and clamoring for wood. Thus logging came to the states bordering the Great Lakes, which in 1870 commenced a 30-year leadership in lumber production.

The period was marked not simply by use, but by wasteful exploitation, followed by devastating fire. In 1871, the nation was shocked by the worst fire in United States history, at Peshtigo, Wisconsin, in which 1,500 persons lost their lives and nearly 1,300,000 acres were burned. Disturbed by the wave of fire and destruction, the American Academy for the Advancement of Science two years later urged Congress and the states to recognize the need for "cultivation of timber and preservation of forests and to recommend proper legislation for securing these objectives." To pursue this program, the American Forestry Association was organized in 1875. Carl Schurz, the German-born Secretary of the Interior, called for a reversal of public opinion, "looking with indifference on this wanton, barbarous, disgraceful vandalism; a spendthrift people recklessly wasting its heritage; a Government careless of its future." As a result, in 1876 Congress enacted a bill providing for a study and report on the forest situation, and "the means best adapted to the preservation and renewal of forests."

During the same era, the Homestead Act of 1862 and subsequent laws were adopted by Congress presumably to encourage, assist and reward Americans who would open frontierlands and settle the West. But the land laws were bypassed and subverted and millions of acres passed into the hands of cattle syndicates, mining nabobs and speculators. The railroads were the real giants, receiving immense domains as "encouragement" to finance construction. Something like half the nation's forests were plucked into private ownership.

THE NATIONAL FORESTS

In the face of the dissolution of the nation's treasures, Yellowstone was set aside in 1872 as a public trust, "withdrawn" from any possible private claim and established as a national park. Thus the foundation was laid not only for additional national parks, but for the Forest Reserve Act of 1891, authorizing the President to withdraw portions of the public domain as "forest reserves." President Benjamin Harrison set aside reserves totaling 13 million acres, while his successor, Grover Cleveland, withdrew an additional 20 million acres. Theodore Roosevelt, however, made the greatest contribution, setting aside 132,000,000 acres—very likely his greatest, most enduring contribution to the Republic—despite fervent, sometimes violent opposition. Today the national forests and national grasslands cover 187,000,000 acres in 41 states and Puerto Rico.

The 1897 Organic Act established the national forests on a firmer footing for the purposes of protecting watersheds and furnishing "a continuous supply of timber for the use and necessity of citizens of the United States." In fulfilling this mandate, Pinchot, the first Chief Forester, and other leaders of the Forest Service recognized that productive lands and an abundance of resources determine the quality of living of any nation. They were oriented to public welfare. Their underlying objective was that each generation should manage the land and its resources in such manner as to leave them to the next generation in a protected and productive condition. In due course, "continuous supply" became known as sustained yield, which means simply that if you are to have a continuous supply of timber, you must not cut it any faster than it grows. Or, the annual allowable cut must not exceed the increment of growth.

On this foundation, the National Forest System grew and developed. The Forest Service is the largest bureau in the Department of Agriculture. The Weeks Law of 1911 provided for purchase of forested lands in the East based on the need for watershed protection. Other laws were designed to advance forest research and to provide aid to state and private woodland management. In 1933, the National Plan for American Forestry, or the Copeland Report (named for its sponsor, Senator Royal S. Copeland), contained the most detailed statistics on American forest conditions ever compiled. It proposed a large extension of public ownership and more practical management of all timberlands. One significant premise was that the nation's 308 million acres of forest and brush land have a major influence on watershed protection. The report showed that, even when aided by public subsidy, private initiative had failed to preserve forest values: fire damage was 11 times greater on private lands than federal lands, and only 0.85 per cent of private forests managed to assure continual growth of timber.

Subsequent studies substantiated the report. The *Timber Resources Review,* published in 1958, showed that annual sawtimber growth was 9 per cent higher than it had been a decade earlier, but that more desirable trees were losing ground to those of poor quality. It showed 60 per cent of commercial forest land divided among 4.5 million farmers and other private owners, mostly in small holdings—on which productivity and management were at their lowest levels. Yet the timber industry consistently greeted Forest Service warnings of potential timber shortages with derision and assurances that "growth exceeds drain," and sought at every turn to block proposals for regulation.

The Forest Service itself manages no more than 17 per cent of the nation's commercial forest land; other federal agencies manage an additional 4 per cent. Private owners hold more than 73 per cent and state and local governments, almost 6 per cent. The state and private forestry program is intended to encourage better practices on 367 million acres of private land.

Early in the century, industrial forestry was based on readily and endlessly available supplies of wood. The timber scouts went first, bringing the news of towering virgin forests. Then followed the sawmills and logging railroads. The flatlands of Mississippi and Louisiana, as an example, were easy to attack: by the 1920's, the land there was cut barren and the big mills had departed, leaving in their wake fierce fires fed by resinous slash scattered on the ground. In the depression years, vast acreages were left to county and state ownership for non-payment of taxes. The industry suddenly found itself pressed against the last virgin timber frontier of the Pacific Northwest.

Drastic change was a necessity. Landowning companies began to harvest timber in ways favorable to natural restocking. They became conscious of the need to cut selectively, leaving some trees to serve as a green protection against fire and to assure regeneration. Enlarged opportunities for foresters provided systematic management in place of hit-or-miss operations. In 1966, it was estimated that nearly 10,000 professional foresters were involved in industrial forest management, compared to fewer than 1,000 in 1941. "It is a tremendous base from which to carry forward more intensive management," said Bernard Orell, vice president of the Weyerhaeuser Company, "even better forest fire prevention and control methods, and to refine through research utilization of the timber supply and the products which result."

Still, there remains the preponderance of small ownerships. The industry's answer to proposals for regulation has been its support of the voluntary American Tree Farm System. Each participating landowner is required to pledge support of basic land management principles, but unfortunately makes no pledge to match cut with growth, so that there is no assurance of scientific management with continuous production at an even rate.

Professor Albert C. Worrell, of the Yale School of Forestry, undertook in 1969 a cursory survey of small private properties, spe-

cifically for the purpose of determining timber supplies. He found that they contain more than their proportionate share of better growing sites, that they are physically capable of producing 4 billion cubic feet of softwood timber a year—equivalent to about 40 per cent of our present consumption—but that they are not producing anything near their potential. On nearly two-thirds of the small forests covered in the survey, timber is harvested occasionally, but without any provision for a future crop.

The conclusions reached by Professor Worrell are most disturbing because they contain more questions than answers. "The forestry profession still cannot estimate how much timber our various forest types can produce under management," he wrote. "We are still resorting to rule of thumb averages."

MULTIPLE USE VERSUS MONOCULTURE

But, of course, providing timber is only one use of the forests. Insofar as public lands are concerned, the national forests are managed under the Multiple Use-Sustained Yield Act of 1960. In a multiple use forest, the immediate values of the timber yield must be balanced with long-range protection of soil, water, wildlife, wilderness and scenery, and with assurances that harvested areas will grow more trees for future timber needs. It is a must of multiple use to protect the flow and quality of water.

"The preservation of forests and game go hand in hand," wrote Theodore Roosevelt in 1893. "He who works for either, works for both." Today many foresters, technically oriented but ecologically ill-informed, insist that timber cutting opens the woodland, increasing the growth of herbs and shrubs for game, giving the impression that "deer" and "game" are synonymous and failing to mention that when one species moves in there is apt to be a mass exodus of many other species. The grizzly bear and wolf have been wiped out of the forests; the elk is confined almost entirely to the Western states. Even today, sportsmen report that "clearcutting" of marginal timber on the steep slopes of the Rockies cuts off elk calving grounds, reduces the summer range, making the areas vehicle-oriented rather than wildlife-oriented, destroying the scenic environment that lends zest to sport—and this on public land. Little wonder, considering the timber sales budget of the Forest Service is *ten times greater* than the budget for fish and wildlife habitat.

The obsession for clearcutting represents one of the major hang-ups in forest management on both public and private land. Thanks to new types of machinery, it is now possible to upend as many as 1,500 to 1,800 trees in the course of a day, thus leveling a timber stand over hundreds of acres in short order. Clearcutting flattens various sized areas, destroying accumulated growth in one swoop.

Observers must focus close attention on the impact of clearcutting and "rotation cycles" on the life-community of the forest. The mixed hardwood or hardwood-and-pine forest is a complex, diverse and stable association of plants, with a tendency to maintain its ecological norm. There is plenty of room for manipulation within the norm, along with growing timber on long rotations. Drastic changes outside the norm—such as clearcutting and the conversion of hardwoods to pine—may be efficient in terms of technology and short-range cellulose production, but are likely to prove disastrous in the long run.

Yet vast areas of the Southland that once supported mixed forests have been reduced to "even-aged" stands of pine only, like apple orchards or orange groves, with few plants desirable for game. True multiple use precludes using forests as farm lots for such monoculture, which inevitably attracts rodents and insects, thus creating the need for pesticides and insecticides (including chlorinated hydrocarbons) and for fertilizers that ultimately take more out of the soil than they put into it. Hardwoods take longer to grow and show a slower return in dollars and cents, but they offer more value to the nation than the mass production of low-quality wood at what must become a steadily reduced rate.

The National Timber Supply Bill of 1969 represented an intensive lobbying effort of the forest products industry to establish log-

ging as the primary role of public and private forests alike. The bill was advanced as a means of providing housing for the poor in American ghettos, yet its strongest boosters in the timber industry have been enjoying record financial returns from the uncontrolled and substantial export of logs to Japan. Simply stated, having cut most of their own holdings, they sought to continue the wave of liquidation in the publicly owned forests. The bill would have provided a timber improvement fund, to be created by the deposit of receipts from timber sales, but carried no safeguard for other values. Consideration of the bill was rejected in the House of Representatives by a vote of 229 to 150, though it may be brought up again in some other form during 1970.

Industrial users of public lands, for such activities as timber, mining and grazing, have bitterly objected to what they call "noneconomic set-asides" of recent years, such as the Wilderness Law, the National Scenic and Wild Rivers Act, the National Scenic Trails Act, and the establishment of the Redwoods National Park and North Cascades National Park. Naturalists and citizen conservationists, however, consider these actions among the most vital efforts to protect the environment made by Congress in the twentieth century.

WILDERNESS LEGISLATION

The Wilderness Law of 1964 was enacted by Congress in order "to secure for the American people of present and future generations the benefits of an enduring resource of wilderness." The law provides for use and enjoyment of wilderness, but in a judicious manner, designed to leave it unimpaired for future use and enjoyment. The law established a National Wilderness Preservation System, which at passage immediately embraced 54 units of the national forests, covering over nine million acres, which had previously been classified administratively as wilderness. It also directed a review over a 10-year period of an additional 34 units, covering approximately 5 million acres, previously classed as primitive areas, for ultimate decision by Congress on their possible inclusion in the Wilderness System. Comparable roadless areas of the national parks and national wildlife refuges are being considered in like manner. Other areas could be added, areas presently called "de facto wilderness"—lands of the national forests which have not been reviewed but which qualify for study. In a highly important precedent-setting court decision handed down in the spring of 1970, the Forest Service was restrained from conducting a logging sale in the de facto wilderness of East Meadow Creek adjoining the Gore Range-Eagle Nest Primitive Area in White River National Forest, Colorado.

How much timber does wilderness deny? In the past decade, about one-fifth of the nation's industrial wood has come from the national forests. About one-half of the total area of the national forests is capable of yielding commercial timber crops. But only five per cent of the productive land is in the wilderness areas. Most of this five per cent is in the high elevations, where the cost of harvest is high and quality of timber is low. Actually, no more than two or three per cent of the long-range timber potential lies inside the wilderness.

On the other hand, wilderness is never single-use land. It provides watershed protection, hunting, fishing, hiking, and other forms of quality recreation in solitude away from congestion. It serves as a preserve for rare and endangered species of plants and animals. (Of 130 species of fish and game classified as rare, endangered or unique by their scarcity, more than 25 are known to live in the National Forest System.) Innumerable laws of nature can never be thoroughly understood without some access to conditions of the primeval.

This value applies not only to federal areas but to others which may be unprotected as well. Thus, concerned citizens of Southern California have recently been making a heroic effort to raise funds in order to save a tract of the rare *Pinus torreyana,* which has absolutely no commercial value. "California has the unique distinction of having within

its boundaries isolated plant communities found growing nowhere else in the world," comments William Penn Mott, Jr., director of California's state parks and beaches. "The Torrey pines found growing naturally only in San Diego County constitute an example of one of these unique plant communities. The preservation of the Torrey pines is of the utmost importance to scientists and ecologists throughout the world."

Such areas of value to the whole world are not generously supported. The nation is addicted to spending large sums in the pursuit of supersonics, space exploration and nuclear explosions, which may represent steps in the growth of human knowledge. But we already have life abundantly present around us, within touch of our fingers and sight of our eyes, and are barely beginning to understand it. A century hence others may look back and think how little we knew about soils, plants, animals, air and life itself. Perhaps one of the key roles of this generation is to insure the availability of resources such as the Torrey pines to the scientists and scholars of tomorrow.

Securing an adequate resource of forest wilderness is one of the challenges facing the nation. There are others of great consequence, including the following:

First, forests need to be considered as an integral part of the city.

They lend charm and comfort to the crowded urban scene, provide daily reminders of man's relationship to nature, and enhance the supply of oxygen. However, growing conditions for city trees have steadily degenerated because of air pollution, drought, heat, erosion, disease, and concentrated use of the land; the loss of trees invariably speeds the destruction of other values. Even more serious, studies show that urbanization can raise the temperature by as much as ten degrees over surrounding woods and fields and cause a concentration of sulfur dioxide.

Urban conservation is a new art—seldom practiced, little understood. The primary target should be to provide more greenbelts, buffer strips, community parks and forests. A program should be conducted by means of federal cooperation and cost-sharing with state and local governments, with a special goal of encouraging city and country forestry departments and private enterprise tree services.

Second, the relationship of forest trees to man and his survival is becoming evident.

Damage to trees and tree crops from various forms of air pollution has hit all sections of the country. The decline of citrus groves in Southern California is due in large measure to Los Angeles smog. Damage to thousands of acres of ponderosa pine in the Arrowhead-Crestline area of San Bernardino National Forest is attributed to the same source. In the Cumberland Plateau of Tennessee, Eastern white pines have been dying over thousands of acres. Investigation has finally traced responsibility to stack gas emissions from a large industrial complex, which includes a steam plant of the Tennessee Valley Authority and the Oak Ridge facility of the Atomic Energy Commission. This disease has been called white pine needle dieback or post-emergency chronic tipburn (PECT). "Unless measures now being taken by various public and private agencies, and spearheaded by the United States Public Health Service, can successfully combat this problem in the near future, we can expect increasing damage to orchard, forest and shade trees," according to Dr. George R. Hepting, of the Forest Service. "We will also likely be recognizing certain kinds of damage to trees as caused by air pollution that we have not known the cause of before."

Trees are needed to combat pollution,

(Continued on page 369)

Michael Frome has written widely on conservation and is a featured columnist in *American Forests Magazine*. His books include *Whose Woods These Are: The Story of the National Forests* (Garden City, N.Y.: Doubleday, 1962), *National Forests of America* (with Orville Freeman) (New York: Putnam, 1968) and *Varmints: Our Unwanted Wildlife* (New York: Coward, 1969). Mr. Frome has lectured on conservation at a number of universities.

". . . marine resources will not be the panacea for the problems of over-population. We will need to draw more heavily on marine resources, but we can do so to an extent which will finally be limited by population size and pollution."

Ocean Resources

By Edward A. Perry, Jr.
Postdoctoral Research Fellow, Department of Geology and Geophysics, Yale University

The world's population will reach catastrophic proportions in the next 30 to 50 years unless the birth rate can be curbed or appropriate technological and societal methods can be developed for supporting the projected world population figure of 6 billion by the year 2000. The ocean must be surveyed to determine its potential for meeting the increased demands on its food and natural resources. The possible effects of our ever increasing marine pollution must also be assessed. In general, the public has been overly optimistic about the ocean's capabilities, yet as we become more dependent on marine resources they will require much more judicious management, especially with regard to pollution.[1] Bear in mind that the sea must support several simultaneous activities, many of which are not necessarily compatible, and that we therefore face difficulties of multiple use.

The sea as a food source is a good example of our over-optimism, yet we probably cannot avoid an increasing dependence upon the oceans. The human diet requires not only food energy (calories), but also a certain amount of high quality protein. Plants are the best caloric food source and are most efficiently grown on land. The phytoplankton (photosynthesizing plankton) are the main marine plants, but they maintain a small standing crop and are therefore difficult to harvest efficiently. Certain geographic areas may be able to benefit from the aquaculture of sessile (attached) algae, but in the main we must depend upon land production for our caloric needs.

However, approximately one-quarter of the world's population already suffers from the severe mental and physical defects of protein deficiency. Here we may reasonably expect the oceans to ease the problem by providing a large inexpensive source of high quality protein. An explanation of the marine food cycle illustrates the difficulties still to be overcome.

A food cycle is essentially an energy transport system. The land cycle is fairly simple, having plants at the base to draw energy from the sun and nutrients from the soil. Man can feed directly on the plants for his main caloric source and directly on the herbivores for his protein, the result being an efficient transfer of energy and nutrients. Bacteria complete the cycle by returning the nutrients to the soil through the processes of decay. While we can produce land plants inexpensively, our herbivores represent a fairly expensive protein source, especially for highly impoverished and overpopulated areas.

The marine food cycle is a much more complex system and cannot be so efficiently

[1] For a general summary of the physical and chemical aspects of the oceans, see Karl K. Turekian, *Oceans* (Englewood Cliffs, N.J.: Prentice-Hall, 1968).

utilized by man. The phytoplankton—mainly diatoms and dinoflagellates—are the base of the food chain, but they deplete the nutrients from the water and therefore are abundant only where the ocean can be replenished by areas of upwellings which bring nutrients from the bottom waters. Such areas are limited and hence so are the oceanic regions capable of supporting commercial fisheries.

Another problem is that we can no longer prey directly on the main herbivores, the copepods, as a protein source, for these small crustaceans are no larger than the head of a pin.

We currently use the second or the third carnivore stage, but there is only a 10 per cent efficiency of food transfer through each trophic (feeding) level of the food chain. Again this makes the oceans a poor place to look for man's caloric needs. Even at the second trophic level, the full potential fishery productivity would provide only one-fifth of the caloric requirements for the world's present population.[2] (See Chart I)

The outlook is much brighter for utilizing marine life as an abundant, inexpensive protein source. Even at the population level projected for the end of this century, we could meet the world's protein requirements by using only one-third of the potential fisheries productivity at the second trophic level.[3] The main problems here are not technological, but social and legal.

The social problems consist of changing the food preferences of many people from meat to fish—and even the need to teach people that fish is a good source of protein. Legal problems arise in the international management of ocean fisheries. On a national level there is a legal problem of permitting fish protein concentrate to be sold for human consumption instead of for livestock feed.

[2] M. P. Schaefer, "The Potential Harvest of the Sea," *Transactions of the American Fisheries Society*, 94 (1965) pp. 123–128.

[3] *Ibid.*

Man's food is currently harvested at the third or fourth trophic level so that we use only about 10 per cent of the productivity of the second trophic level. At present most of the second trophic level harvest is made into fish protein concentrate (F.P.C.) for livestock feed, but by taking the livestock as our protein source, we recover only 30–40 per cent of this protein and at much higher prices. Also, we obviously need careful fisheries management, not only for the exploited species, but for the related competitors and predators. Because most of our fisheries are in international waters, this becomes an extremely complex legal as well as a technological problem.

One final topic, aquaculture,* should be mentioned, since it has received wide publicity as a possible answer to our food problems. Unfortunately, it probably cannot supply the needed large and inexpensive sources of protein because it is generally limited to species higher in the food chain. For example, sardines and anchovies can be harvested at $15 to $30 per ton, while at present, the products of aquaculture cost about $100 per ton. For comparison, however, chickens cost at least $250 per ton and cows and pigs even more, so that aquaculture may continue to prove feasible for the highly desired marine products such as clams, oysters, shrimp and yellowtail. The amounts produced will still fall far short of the large protein volumes needed in the next few decades.

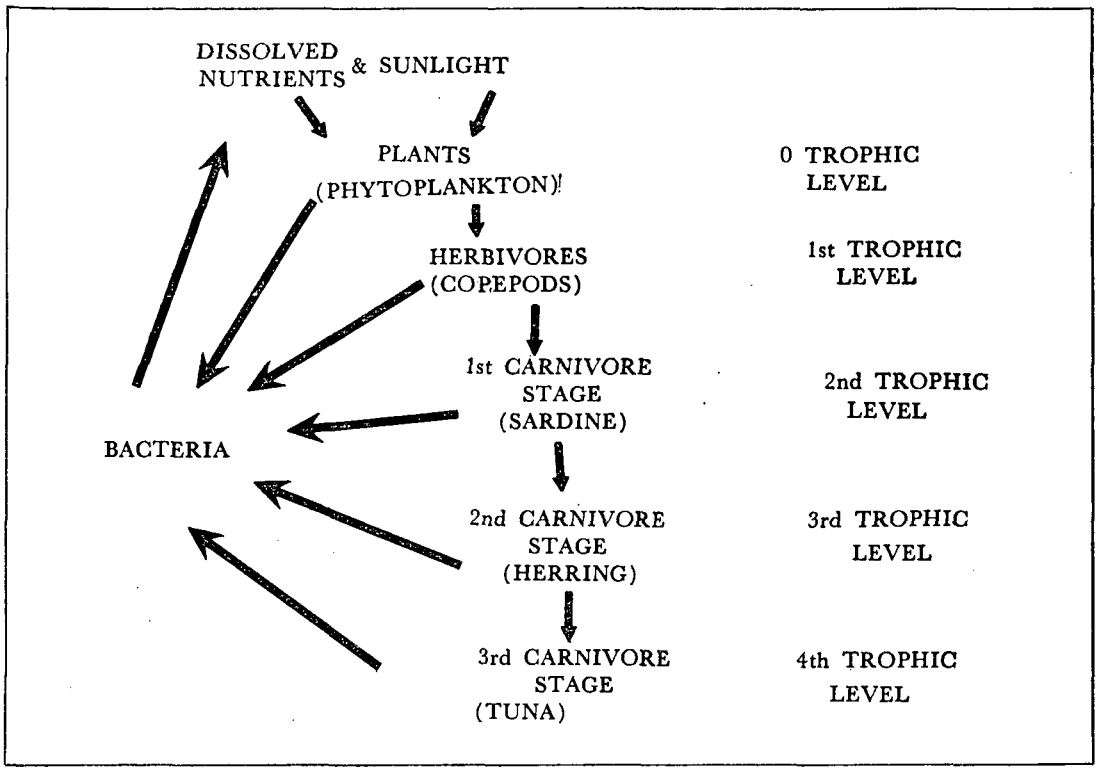
CHEMICALS AND MINERALS

Sea water can be defined as a salt solution of sodium chloride, potassium chloride, magnesium sulfate and calcium bicarbonate. The rest of the dissolved constituents are present only in minor amounts and may be called trace elements. Fortunately, most of our needed elements have already been efficiently concentrated by natural processes and now occur in more economically accessible continental deposits. All the trace elements are found in higher concentrations in crustal rocks than in sea water.

We are currently extracting some chemicals

* *Editor's note:* Aquaculture refers to the breeding and raising of fish in protected pools for stocking lakes and streams.

CHART I
Trophic or Feeding Levels



from sea water (Table I), usually where nature has already helped in concentrating them by high evaporation rates. Except for these commodities, it is unlikely that we will be able to extract chemicals as efficiently from the sea as from existing land deposits. Even in the case of the trace metals, it would be best to utilize fresh water streams where the metals are present in about the same concentrations, but free from interference by the more abundant sea salts. Also, streams offer a more easily directed flow for processing. As the population grows and we need more fresh water, desalinization of sea water will become more economical and more chemicals may be extracted as by-products.

Our largest potential reservoirs of oil and gas may be located beneath the ocean in the continental shelf rocks. Extensive offshore drilling is already in progress in the Gulf of Mexico and the North Sea, and vast areas of the continental shelves are currently being explored by geophysical techniques. Production has already been started in water depths of 400 feet and exploratory drilling has begun at 1300 feet.

Oil and gas currently account for 40 per cent of our power, and while the relative per cent may actually decrease due to atomic power, the absolute amount will probably increase with the expanding population. The ultimate production from continental shelves may range from about 20 billion to 200 billion barrels of oil and 120 trillion to 1,000 trillion cubic feet of gas, depending on the water depths feasible for drilling.[4] The problem here will not be the amounts available, but the prevention of pollution from drilling and transportation.

Ocean mining grossed about $200 million in 1967 for total world production. Sand and gravel accounted for 50 per cent of the total; sands containing heavy minerals such as tin and iron, 20 per cent; shells, 15 per cent; sulphur, 8 per cent; and diamonds from

[4] *Report of the Panel on Marine Resources,* Part VII, Sec. 3 (Washington, D.C.: U.S. Government Printing Office, 1968).

TABLE I: CHEMICALS EXTRACTED FROM SEA WATER*

	Tons/yr	% of total world production (1967)
Sodium chloride	35,000,000	29
Bromine	102,000	70
Magnesium metal	106,000	61
Magnesium compounds	690,000	6
"Manufactured" fresh water	142,000,000	59

* net annual value ~ $400 million

sands, 5 per cent.[5] Improved technology may allow us to recover more of these deposits, but for some time to come the commodities produced will probably remain about the same. Continental ore deposits are much more economically exploited.

Mineral resources that have received much public notice are the deep-sea, low grade (.1–.7 per cent) deposits of cobalt, nickel and copper. These metals are associated with the manganese-iron nodules in water depths of about 3,000 feet. Recovery presents a serious technological problem, and the economic market for these metals would not support such a new supply for several decades.

Marine resources, in the light of a rapidly expanding population, generally seem more than adequate until the year 2000. But because of population and industrial growth, man can (and in some cases, already does) have a serious impact upon the oceans. We must now face the problems of multiple use for our marine resources. In populous areas we often call upon the marine environment to provide simultaneously food, transportation, waste disposal, recreation and even mineral and oil resources. Unless properly managed, these several uses are not mutually compatible, and at present we lack the technology and, more important, the societal concern necessary for such delicate management.

The main problem is pollution.** Most of the largest metropolitan and industrial areas border estuaries, for the estuary is usually semi-enclosed and provides a natural harbor and transportation link to inland areas. It is also an effective nutrient trap and is therefore rich in food, and the high rates of tidal flux and flush permit waste disposal. But already most of our estuaries can no longer support the current pollution influx. One can see this in Boston Harbor, the Hudson River, Galveston Bay, San Francisco Bay and numerous other populous estuarine areas. The major sources of pollution, current or potential, are municipal sewage, oil spills, thermal pollution, nuclear wastes and runoff from agricultural areas. Industrial pollution is not dealt with separately because of the wide range of pollutants, many of which are similar to or have the same effects discussed below.

First, consider the problem of human waste disposal. If the sewage is initially untreated, the effects are obvious in the microbes harmful to man and marine organisms. Many forms of marine life actually concentrate such microbes and are lost as a food source even at low contamination levels. The effects also damage recreational activities like boating, sport fishing and swimming, and reduce land values near the water. Most estuaries can no longer support such disposal due to the larger populations and industries, but the practice often continues. Galveston, for example, dumps 1.5 million gallons of raw sewage *per day*.[6]

Many municipalities have primary or secondary treatment plants which chlorinate to destroy harmful microbes and filter out solid wastes. Unfortunately, we are now finding that such treatment plants are insufficient for two reasons. First, many cities have very old combined sewer systems to handle human wastes and storm runoff simultaneously. During high rain periods, most plants cannot process the large volumes of sewage and overflow gates allow raw sewage to pass directly into the estuary.

The second problem is more subtle, but the effects can be equally serious. While primary or secondary treatment kills harmful microbes, it does not remove nutrients (e.g.,

[5] *Ibid.*

** *Editor's note*: For further treatment of the problems of pollution, see *Current History*, July and August, 1970.

[6] L. J. Carter, "Galveston Bay: Test Case of an Estuary in Crisis," *Science*, 167 (1970), pp. 1102–1108.

nitrogen and phosphorus) from the effluent. The estuary can thus become "overfertilized" and subject to dense algae blooms. In addition to creating a foul stench and eyesore, the overproduction of algae depletes the water's oxygen supply and limits the more desirable food and game species.

The problem does not stop with the ecological disruption of the estuary, for many of the open ocean fish have life cycles directly tied to estuaries or feed upon fish which do. Oxygen blocks at the mouths of rivers will prevent fish from spawning in the estuaries or farther upstream. Salmon have long since disappeared from the Hudson and Connecticut Rivers, and menhaden, herring, anchovies and other commercially valuable and potential protein sources depend directly upon estuaries and rivers.

Unfortunately, tertiary sewage treatment plants cost about twice as much as the older plants, but in the absence of such plants the long-range economic losses are also very large. Recreational and marine service industries are of considerable monetary value, and water front land values will and are already decreasing in many areas. The ecological damage could eventually cost humanity even more in the loss of a potential food source.

With increased demands, more oil will be extracted from beneath the sea and transported across the oceans. The huge oil spills from the Santa Barbara Channel offshore wells (over 10,000 tons), in the Gulf of Mexico, and the wreck of the *Torrey Canyon* off England (100,000 tons) have dramatically demonstrated the pollution potential of both drilling and transport.

The pollution from smaller incidents of oil well leakage and from the shipping practices of bilge and ballast flushing at sea has become serious. Even in such remote areas of the open ocean as the Sargasso Sea, oil and tar have fouled plankton nets so seriously that a research vessel could not continue sampling activities. One million tons of oil are lost annually at sea, representing .1 per cent of all oil transported across the ocean,[7] and this does not include oil spills from offshore wells or oil introduced by industrial effluents. Many of the effects of oil pollution, especially with respect to marine life, are not yet known, but we do know that recreational and marine service industries as well as land values suffer. The spills are neither easily nor quickly removed. The gasolines in low concentration cause anesthesia and narcosis to marine life and, in higher concentrations, cause cell damage and death, especially to larval and other immature forms. The heavier oils are not so toxic, but may interfere with nutrition.

The light aromatic hydrocarbons are acute poisons for man as well as most other organisms. The detergents used to disperse the *Torrey Canyon* oil spill were dissolved in aromatics and their application multiplied the damage to coastal life—a technique obviously to be avoided in the future. The heavy aromatics are suspected of being long-term poisons, especially as cancerous tumor initiators, and are similar to the dangerous tars in tobacco smoke. We are still ignorant of the long-term and low-level contamination effects.

Man feeds at a high level of the marine food chain, and the hydrocarbons that have been ingested by an animal are passed along or concentrated in the food chain. The pattern is similar to the chlorinated pesticides concentrated in Great Lakes fish. Dispersion of oil by chemicals or by natural means also produces oil droplets of such small size that they are ingested by many marine animals. Ecological systems can be upset by oil pollutants as many marine predators are attracted to prey by organic compounds often present at less than 1 part per billion. The same process works for avoidance, homing, selection of habitat and reproduction. Pollution can block the taste receptors or mimic the natural stimuli.

Correction of oil spills is a very difficult problem because dispersion still subjects marine life to pollution and sinking spills by hydrophobic compounds affects bottom fauna. Burning or recovery by confinement

[7] M. Blumer, "Oil Pollution of the Ocean," *Oceanus*, 15, no. 2 (1968), pp. 2–7.

is difficult and not always feasible. Therefore we must obviously improve our prevention and law enforcement techniques, especially with the continued expansion of offshore drilling, oceanic transport by supertankers and an oil-based industrial technology.

POWER PRODUCTION

As indicated earlier, we will not have to depend directly upon the sea for power, nor is it feasible to utilize tidal energy. But within 30 years there will be a ninefold increase of power production which will require the disposal of 20 million B.T.U.'s (British Thermal Unit) of waste heat per day. To carry off this much heat would require about one-third of the average daily United States runoff, and many of the power plants will be built in coastal and estuarine areas. Therefore we are now faced with a potential thermal pollution of our marine resources, mainly in the estuaries, on which much of marine life directly or indirectly depends.

Increased water temperatures aid excessive algal blooms and harmful microbes. They also raise the metabolic rate of organisms which in turn can cause anoxia, increased respiration and higher oxygen needs, with oxygen already being depleted by existing pollution. Reproduction habits also are commonly sensitive to temperature effects. The end results can be as serious as, and similar to, the pollution caused by the excessive nutrients discussed earlier. Cooling towers must be used to avoid thermal pollution. George Clayton, a Michigan consultant on pollution, stated that they may add $5 million to $10 million to the cost of a generating plant, "but put it in terms of kilowatt-hours and it's cheap—perhaps 25 cents a month more to the householder."

Many of the new power plants will be nuclear and there is still another potential form of pollution from their radioactive wastes. These wastes require special care because: (1) they constitute hazards in extremely low concentrations, (2) they cannot be eliminated by chemical transformation and (3) we must live with the radioactive nuclides until they become inactive by natural decay, which for some isotopes is an extremely long process.

With reasonable precautions, the direct hazards are not great for we are already exposed to approximately 50 times more natural radiation from rocks and soil than from sea water, so that it would take huge amounts of nuclear pollution to contaminate the oceans. The indirect hazards can be very significant because of natural processes which can concentrate radioisotopes. Most of the trace elements, including radioactive elements, are concentrated by inorganic processes in the estuaries. Furthermore, marine organisms can get larger dosages by ingestion and can even concentrate certain isotopes by factors up to several thousand and then transfer the contamination up the food chain to man again. Great care must be taken to insure the proper design of the nuclear power plant to avoid both thermal and nuclear pollution.

The causes of marine pollution cited above may be considered as stemming from point sources, a sewerage plant, an industrial plant, and so forth, but we must also contend with broad sources of pollution which are much harder to control: the abundant fertilizers and biocides (pesticides and herbicides) currently in use privately and commercially. Runoff brings these substances into rivers, to estuaries and eventually to the ocean. Fertilizers cause the excessive nutrient problem while the biocides are often very slow to break down and can be concentrated by marine organisms. Judicious use and the development of more specific, shorter lived biocides is required.

Obviously, marine resources will not be the panacea for the problems of overpopulation. We will need to draw more heavily upon marine resources, but we can do so to an extent which will finally be limited by population size and pollution. The problems of

(Continued on page 365)

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"The optimum population for a highly-developed, industrialized nation with a high per capita G.N.P. (gross national product) is very much lower than the population that can be supported at a subsistence level in an undeveloped nation, because the per capita consumption of resources and the production of wastes are so much greater in the developed countries."

Optimum Population and Environment: A Georgian Microcosm

By Eugene P. Odum
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The world seems to be getting smaller and more limited in its capacity to support human beings because the per capita use of resources in developed countries, and the per capita expectations in undeveloped countries, keep going up. Thoughtful persons everywhere are agreeing, perhaps reluctantly in many cases, that if a high quality human existence is to be achieved man must now "manage" his own population as well as the natural resources on which he depends.*

To the ecologist, this means first and foremost that the population growth rate must be drastically reduced so that an equilibrium can be reached in the very near future if we are to avoid the very high risk of excessive population, reduction in the per capita availability of resources and a loss in the individual's freedom of action. If this is indeed the case, then the question of what constitutes an optimum population density for man becomes a key issue. An ecological approach to this problem involves considering the total demands that an individual makes on his environment, and how these demands can be met without degrading or destroying his living space or *lebensraum*.

Since the environment is both a "supply depot" and a "house" for man, the concept of the integrated system, the "ecosystem," is the basis for the relevant ecology of today. In the conduct of human affairs in the past, these two functions of the environment have been considered as separate and unrelated problems, as many writers are now pointing out.[1] The dramatic change in peoples' attitude towards their environment and the rise of a sort of "populist" ecology in the 1970's stem from a general recognition that the quality of the *lebensraum* is so intimately interrelated with the rate of production and consumption of resources that the total "man-in-nature" ecosystem must now be the basis for intelligent management. Lewis Mumford places this concept in more general terms when he says that "Ideological misconceptions have impelled us to promote the expansion of knowledge, power, productivity, without inventing any adequate systems of controls," and that therefore "the problem of our age" is how to use quality to control quantity.[2] In actual fact, it will be much

* This article is based on the sixth and final presentation in a public lecture series: "Ecology 1970—Principles for Action," sponsored by the Institute of Ecology, University of Georgia, Winter Quarter, 1970. Copyright held by the author.

[1] See, for example, historian Lynn White's essay entitled "The Historical Roots of Our Ecological Crisis," originally published in SCIENCE, 115: 1203, 1967, and widely reprinted in paperback.

[2] See *Natural Resources: Quality and Quantity* (Berkeley: University of California Press, 1967), pp. 7–18.

TABLE 1. WORLD DISTRIBUTION OF PER CAPITA G.N.P.

Per capita G.N.P. ($)	Number of countries	% world population
40–149	31	56.5
150–299	25	8.8
300–599	15	4.7
600–2400	16	30.0

Source: Revelle in *Prospects of the World Food Supply* (Washington, D.C.: National Academy of Science, 1966) Table 1, p. 24.

easier to "invent" controls than to agree on a "set point," or optimum level, for the "population-stat."

THE GEORGIAN MICROCOSM

In the fall of 1969, my class in advanced ecology at the University of Georgia elected to tackle the question of "the optimum population for Georgia" on the assumption that this state was large enough and typical enough to be a sort of "microcosm" for the nation and the world. The basic question asked was: How many people can Georgia support at a reasonably high standard of living on a continuing, self-contained equilibrium basis, in the sense that imports and exports of food and resources would be balanced. As it turned out, Georgia is a good microcosm for the United States because its present density and growth rate, and the distribution of its human and domestic animal population are close to the mean for the whole nation. Likewise, food production and land use patterns in Georgia are average. Furthermore, since pollution, overcrowding and loss of non-renewable resources have not yet reached very serious proportions, the state, like most of the nation, has the opportunity to plan ahead for a new kind of "progress," based on the right of the individual to have a quality environment and to share in the economic benefits of wise use and recycling of resources.

It is self-evident that such planning must start at the local and state level. The ecological and population situation is so varied in the nation as a whole that it is not likely that a nationwide plan for optimum population and environment can be initiated until states and regions take their inventories and set tentative standards. For example, the impetus to redesign the internal combustion engine to reduce air pollution started in California where the problem was locally acute. And once California sets rigorous control standards the nation must quickly follow, because manufacturers have to meet maximum, not minimum, standards, since they cannot (for long, at least) build one kind of car for California and another for other states.

As background for the Georgia inventory, two general principles were adopted. The first principle can be stated as follows: "The optimum is almost always less than the maximum." In terms of human population density, the number of people in a given area that would be optimum from the standpoint of the quality of the individual's life and his environment is considerably fewer than the maximum number of people that might be supported, that is, merely fed, housed and clothed as dehumanized robots or "domestic animals." The same principle can be applied to automobiles; certainly the greatest number of cars that can be accommodated bumper-to-bumper on a freeway is not optimum for the forward progress of the individual automobile. Perhaps, then, the idea of the "greatest good for the greatest number" is not really a tenable principle. Maybe Dr. George Wald's slogan, "a better world for fewer babies" is more relevant to our times.

A second principle is that affluence actually reduces the number of people who can be supported by a given resource base. Thus, the optimum population for a highly developed, industrialized nation with a high per capita G.N.P. (gross national product) is very much lower than the population that can be supported at a subsistence level in an undeveloped nation, because the *per capita* consumption of resources and the production of wastes are so much greater in the developed countries. Thus, if one person in the United States exerts 50 times more demand on his environment than does an Asian, then it is obvious that no environment can support as

many Americans as Asians without disastrous deterioration in the quality of that environment. Table 1 illustrates how sharply our world is divided into "developed" and "undeveloped" nations. The distribution of G.N.P. is strongly bimodal, with very few people living in intermediate (so called "developing") nations. Shocking as it may seem, the United States is now in as much danger of overpopulation at its level of per capita living as is India at her present standard of living. Population control must be an overriding issue in both the developed and undeveloped worlds, but the levels that are critical, the limiting factors and the strategy of control are quite different.

MINIMUM AMERICAN PER CAPITA ACREAGE REQUIREMENTS

Table 2 is the consensus estimate made by the students of the minimum acreage necessary to support one person at a standard of living now enjoyed by Americans, including a pollution-free living space, room for outdoor recreation and adequate biological capacity to recycle air, water and other vital resources. The per capita area required for food was obtained by taking the diet recommended by the President's Council on Physical Fitness and determining how much crop and grazing land is required to supply the annual requirement for each item. If Americans would be satisfied with merely getting enough calories and greatly reducing their consumption of meat, as little as a third of an acre per person would be adequate, but the kind of diet Americans now enjoy including orange juice, bacon and eggs for breakfast and steaks for dinner—all of which require a great deal of land space to produce —takes at least 1.5 acres per capita. Thus, the American "demands" from his agricultural environment 10 times the space that is required to produce the rice diet of the Oriental (assuming equally efficient crop production in both cases). The one-acre requirement for "fibers" is based on present per capita use of paper, wood, cotton and so forth, that equals the average annual production of one acre of forest and other fiber-producing land. The two acres for "natural area use" are based on the minimum space needs for watersheds, airsheds, green belt zones in urban areas, recreation areas (state golf courses) as estimated by recent land use surveys. Again, we could do with less by designing more artificial waste recycling systems and doing away with outdoor recreation, but at a high cost to society as a whole.

TABLE 2. MINIMUM PER CAPITA ACREAGE REQUIREMENTS FOR A QUALITY ENVIRONMENT

Food-producing land	1.5 acres
Fiber-producing land	1 acre
Natural use areas (watershed, airshed, greenbelt, recreation, waste disposal, etc.)	2 acres
Artificial systems (urban, industrial, highways, waste treatment facilities, etc.)	0.5 acres
TOTAL	5.0 acres

In considering the five-acre per capita estimate, two points must be emphasized: (1) If the per capita use goes up in the future, either more land is needed or greater production per acre must be forced by increased use of chemical controls that, in turn, tend to pollute the total environment, creating a cost in taxes that would reduce the individual's "take home" pay. (2) The five-acre estimate is relevant only to an area such as Georgia that has a favorable climate (adequate rainfall and moderate temperature). The per capita area requirement would be much greater in regions with large areas of deserts, steep mountains or other extreme ecosystems.

The inventory of Georgia is summarized in Tables 3–6. The per capita density (Table 3) of 1 in 8 acres compares with the national average of 1 in 10 acres. The urban-rural distribution is comparable to the national average. A domestic animal population 5 times that of people is also close to the national average, as is the 10 per cent of land devoted to agriculture (see Table 4). In considering the impact of man on his environment, the importance of the domestic animal is too often overlooked; yet such animals are actually consuming more "primary production" (i.e., photosynthetic con-

TABLE 3. GEORGIA: AREA AND DENSITY, PEOPLE AND DOMESTIC ANIMALS

Total area	37.7 million acres
Total people	4.8 million
Per capita density	1 in 8 acres
Population density— (31% Atlanta met. area.: 60% urban, 56% under 30 yrs. of age.)	
Domestic Animals	
Population equivalent*	21 million
Total Man-Animal	26 million
Population equivalent*	1 in 1.5 acres

* Population equivalent is a unit of animal weight equivalent in metabolism to one adult person.

version of sun energy to organic matter) than man, and they require huge amounts of land. Also, in this country, pets such as dogs and cats are estimated to consume enough food to support five million people. We could do away with all domestic animals, of course, and substitute people, but to the ecologist that would mean not only giving up meat in the diet, but also dehumanizing man to the level of a domestic animal. It is interesting that Georgia now produces enough food to feed 12 million people, provided that people actually consumed the crops directly. A diet of corn, other grains, soy beans, peanuts and vegetables could supply adequate calories and protein. In actual practice, of course, very little of Georgia's crop production is consumed directly; most of it is fed to animals or shipped out of state in exchange for food from elsewhere.

If we consider for the moment that one person in five acres is a reasonable per capita density, then Georgia is rapidly approaching that level. As shown in Table 6, the net growth rate is two per cent which, if continued, would mean a doubling of the population (leaving only four acres per capita) in 35 years. Almost before we realize it Georgia is moving from what was considered essentially a sparsely populated state to one that is beginning to feel the adverse effects of population pressure. As emphasized, this pressure is due not so much to the number of people, but to the great increase in the per capita demands on space and resources. It comes as a shock to everyone that Georgia and the nation could be badly overpopulated by the year 2000.

NATURAL REGULATORS

It is possible to prepare graphic models for population growth and stabilization to show how animal populations in nature normally regulate their density well below the limit that would be imposed by the food supply.[4] In this event the quality of both the individual and the environment is insured, since the individual is neither likely to run out of food (or other resources) nor to "overgraze" or otherwise permanently damage his habitat in his efforts to obtain the necessities of life. In some populations, death controlled by predators, disease or parasites is the regulator; in other populations, birth control is the mechanism. In some of the best regulated species of the most highly evolved animals, namely the birds and the mammals, the essential control is behavior that restricts the use of space.

This sort of "territorial control" would seem to be relevant to the human population problem. Best of all, planned and controlled land use mutually agreed upon through the democratic process can be accomplished at the local and state level right now, while we continue the discussions about birth control and abortion in an effort to reach some kind

TABLE 4. GEORGIA—LAND USE IN 1968

	(per cent)
Crops	
food	7.5
fiber	.8
idle (rotated)	3.7
Pasture	7.4
Forest	
private	66.3
public	4.5*
Recreation (public)	1.8*
Coastal wetlands	1.3*
Urban, etc.	4.5

* Total of these 3 categories or 7.6% is all land now set aside for "natural use" only (i.e., protected from exploitation).

[4] Several such models were prepared for the University of Georgia lecture series. See footnote* above, p. 355.

TABLE 5. FOOD PRODUCTION IN GEORGIA —1969

	Kcal/year × 10^{12}*
Corn	8.5
Grain	0.6
Sweet Potatoes	0.03
Soy Beans	1.8
Peanuts	1.4
Vegetables	0.05
Total	± 12 × 10^{12}

* 10^6 Kcal will support one person one year.

of national and international consensus that can make these approaches effective nationwide and worldwide. Consequently, it certainly will be worthwhile to consider what we might accomplish along the lines of territorial control through land use planning.

LAND USE PLANNING

In actual fact, Georgia is extremely vulnerable to overpopulation for two reasons: (1) the immigration rate is high and can be expected to increase as people flee from the crowded, polluted and deteriorated part of our country and (2) land is open to immediate exploitation on a huge scale because there are so few protective laws and so little land in public ownership. Many of these factors apply to other areas of the nation. Even if the birth rate drops in Georgia and other less crowded states, population growth rate would remain high because of immigration that will come as people discover the relatively cheap and quickly available "open spaces." As already indicated, a growth rate of two per cent per year means that Georgians would be down to one man in 4 acres in 35 years.

A land speculation spiral that is economically ruinous to all but a few speculators could well result unless plans are made now, and control legislation is enacted. Georgia has a lot of open land now but very little has been set aside to remain so. Only about seven per cent of Georgia (see Table 4) is reserved in national, state or city parks, refuges, greenbelts or other protected categories; even our best farmland is vulnerable to real estate exploitation.

As citizens, what can Georgians do? First, they can instigate and support drives, both at the local and state levels, to get more land into public ownership (parks, state and national forests, greenbelts) and can work to have an "open space" bill passed that will enable private owners to establish scenic easements and other restrictions on the use of land that is valuable in its natural state. Second, they can work towards the establishment of metro-commissions and state-wide environmental commissions with strong zoning powers. The passage by the Georgia legislature of the marshlands protection bill early in 1970 was a step in this direction because almost half a million acres were put into a protective category with an agency empowered to insure the best and highest use of a natural resource that otherwise is very vulnerable to destructive types of exploitation.

TABLE 6. 1970 ESTIMATES OF POPULATION GROWTH-RATE IN GEORGIA

	(per year)
Birth rate	2.4%
Immigration	0.4%
Death rate	0.8%
Net growth rate	2.0%

If about one-third of the area of Georgia were in a protected category, then we would be well protected against overpopulation, and we would have a big buffer that would make the technical problems of pollution control much easier. It is important to note that Western states are fortunate in that 40–50 per cent of their land is already in public ownership. The battle there will be to mobilize public opinion to prevent overdevelopment and degradation of these lands.

The third function that citizens can perform is to be more selective about the type

(*Continued on page 365*)

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THE MONTH IN REVIEW

A CURRENT HISTORY chronology covering the most important events of April, 1970, to provide a day-by-day summary of world affairs.

INTERNATIONAL

Berlin Crisis

Apr. 28—Tolls on West Berlin's highway and canal access routes are raised about 30 per cent by the East German government, as a 4-power conference meets to discuss the tense situation in West Berlin. (See *Current History,* May, 1970, p. 311.)

Disarmament

Apr. 17—The second round of Strategic Arms Limitation Talks (SALT) opens in Vienna as U.S. and Soviet negotiators meet for 75 minutes. (See *Current History Annual 1970,* p. 4.)

Apr. 27—Gerard Smith, chief U.S. delegate, and Vladimir Semyonov, chief Soviet delegate, hold their fourth meeting in the current series of SALT talks. Each delegate is still stating the position of his own country, but has not yet started responding to the statements of the other.

Middle East Crisis

Apr. 2—An 8-hour battle involving tanks and jet fighter planes occurs between Israeli and Syrian forces.

Apr. 8—Egyptian sources claim that Israeli jets attacking military targets in the U.A.R. have bombed a school, killing 30 and wounding 46.

Apr. 10—Joseph Sisco, a U.S. Assistant Secretary of State, arrives in Cairo for talks with President Gamal Abdel Nasser on specifics of a peace settlement of the Arab-Israeli conflict.

Apr. 19—Israeli spokesmen say one U.A.R. jet has been downed and 2 more have been hit in an attack against Israeli positions along the Suez Canal.

Apr. 21—U.A.R. jets strike Israeli positions again. The Israelis announce the downing of one attacking plane, the 55th MIG-17 downed since the end of the 1967 war.

Apr. 22—Arab commandos toss a grenade into the main square of Nablus in Israeli-occupied Jordan, injuring 3 American tourists.

Apr. 24—Targets in Syria, Jordan and the U.A.R. are struck by Israeli jets.

Apr. 25—Syrian MIG-21's strike Israeli bunkers in the Golan Heights.

Apr. 28—Diplomatic sources in Israel say that Soviet pilots are flying MIG-21's for the U.A.R. air force. The planes are not taking part in attacks on Israel but are guarding Soviet anti-aircraft missile installations behind the border.

Apr. 30—Israeli Foreign Minister Abba Eban asks the U.S. for military aircraft in the wake of reports that Soviet pilots are flying jet fighters in defense of Egyptian bases.

In the biggest engagement since the June, 1967, war, a battalion of Egyptian troops crosses the Suez Canal to attack Israeli positions.

United Nations

Apr. 16—Soviet delegate to the U.N. Yakov Malik tells a news conference at the U.N. that a new Geneva Conference could bring a solution to fighting in Indochina.

War in Vietnam

(See also *Intl, U.N.; Cambodia; U.S., Foreign Policy*)

Apr. 1—Renewed fighting breaks out as a series of artillery and ground attacks is launched by North Vietnamese and Vietcong forces.

Apr. 5—The heaviest fighting since November occurs along the demilitarized

(*Continued on page 370*)

President Nixon's Message on the Environment, 1970

On February 10, 1970, President Richard Nixon sent a message to Congress setting forth the administration's proposals for legislation on the environment. Excerpts from the message follow:

Like those in the last century who tilled a plot of land to exhaustion and then moved on to another, we in this century have too casually and too long abused our natural environment. The time has come when we can wait no longer to repair the damage already done, and to establish new criteria to guide us in the future.

* * *

The tasks that need doing require money, resolve and ingenuity—and they are too big to be done by government alone. They call for fundamentally new philosophies of land, air and water use, for stricter regulation, for expanded government action, for greater citizen involvement, and for new programs to insure that government, industry and individuals all are called on to do their share of the job and to pay their share of the cost.

Because the many aspects of environmental quality are closely interwoven, to consider each in isolation would be unwise. Therefore I am today outlining a comprehensive, 37-point program, embracing 23 major legislative proposals and 14 new measures being taken by administrative action or executive order in five major categories:

Water pollution control.
Air pollution control.
Solid waste management.
Parklands and public recreation.
Organizing for action.

As we deepen our understanding of complex ecological processes, as we improve our technologies and institutions and learn from experience, much more will be possible. But these 37 measures represent actions we can take now and that can move us dramatically forward toward what has become an urgent common goal of all Americans: the rescue of our natural habitat as a place both habitable and hospitable to man.

* * *

Water pollution has three principal sources: municipal, industrial and agricultural wastes. All three must eventually be controlled if we are to restore the purity of our lakes and rivers.

Of these three, the most troublesome to control are those from agricultural sources: animal wastes, eroded soil, fertilizers and pesticides.

* * *

Many of the same techniques of pest control, livestock feeding, irrigation and soil fertilization that have made American agriculture so abundantly productive have also caused serious water pollution.

Effective control will take time, and will require action on many fronts: modified agricultural practices, greater care in the disposal of animal wastes, better soil conservation methods, new kinds of fertilizers, new chemical pesticides and more widespread use of natural pest control techniques.

A number of such actions are already under way. We have taken action to phase out the use of DDT and other hard pesticides. We have begun to place controls on wastes from concentrated animal feed-lots. We need programs of intensified research, both public and private, to develop new methods of reducing agricultural pollution while *maintaining productivity.*

I have asked the Council on Environmental Quality to press forward in this area. Meanwhile, however, we have the technology and the resources to proceed now on a program of swift cleanup of pollution from the most acutely damaging sources: municipal and industrial waste.

* * *

In the four years since the Clean Waters Restoration Act of 1966 was passed, we have failed to keep our promises to ourselves: Federal appropriations for constructing municipal treatment plants have totaled only about one-third of authorizations. Municipalities themselves have faced increasing difficulty in selling bonds to finance their share of the construction costs.

* * *

The best current estimate is that it will take a total capital investment of about $10 billion over a five-year period to provide the municipal waste treatment plants and interceptor lines needed to meet our national water quality standards. The figure is based on a recently completed nationwide survey of the deficiencies of present facilities, plus projections of additional needs that will have developed by then to accommodate the normal annual increase in the volume of wastes, and to replace equipment that can be expected to wear out or become obsolete in the interim.

This will provide every community that needs it with secondary waste treatment in areas of special need, including communities on the Great Lakes. We have the industrial capacity to do the job in five years if we begin now.

To meet this construction schedule, I propose a two-part program of federal assistance:

I propose a clean waters act with $4 billion to be authorized immediately, for fiscal 1971, to cover the full federal share of the total $10-billion cost on a matching fund basis. This would be allocated at a rate of $1 billion a year for the next four years, with a reassessment in 1973 of needs for 1975 and subsequent years.

* * *

A river cannot be polluted on its left bank and clean on its right. In a given waterway, abating some of the pollution is often little better than doing nothing at all, and money spent on such partial efforts is often largely wasted.

Present grant allocation formulas—those in the 1966 act—have prevented the spending of funds where they could produce the greatest results in terms of clean water.

* * *

To insure that the new funds are well invested, five major reforms are needed. One requires legislation; the other four will be achieved by administrative action.

I propose that the present, rigid allocation formula be revised, so that special emphasis can be given to areas where facilities are most needed and where the greatest improvements in water quality will result.

Under existing authority, the Secretary of the Interior will institute four major reforms:

Federally assisted treatment plants will be required to meet prescribed design, operation and maintenance standards, and to be operated only by state-certified operators.

Municipalities receiving federal assistance in constructing plants will be required to impose reasonable users' fees on industrial users sufficient to meet the costs of treating industrial wastes.

Development of comprehensive river basin plans will be required at an early date, to insure that federally assisted treatment plants will in fact contribute to effective cleanup of entire river basin systems. Collection of existing data on pollution sources and development of effluent inventories will permit systems approaches to pollution control.

Wherever feasible, communities will be strongly encouraged to cooperate in the construction of large regional treatment facilities, which provide economies of scale and give more efficient and more thorough waste treatment.

* * *

I propose a seven-point program of measures we should adopt now to enforce control of water pollution from industrial and municipal wastes, and to give the states more effective backing in their own efforts.

I propose that state-federal water quality standards be amended to impose precise effluent requirements on all industrial and municipal sources. These should be imposed on an expeditious timetable, with the limit for each based on a fair allocation of the total capacity of the waterways to absorb the user's particular kind of waste without becoming polluted.

I propose that violation of established effluent requirements be considered sufficient cause for court action.

I propose that the Secretary of the Interior be allowed to proceed more swiftly in his enforcement actions, and that he be given new legal weapons including subpoena and discovery power.

I propose that failure to meet established water quality standards or implementation schedules be made subject to court-imposed fines of up to $10,000 per day.

I propose that the Secretary of the Interior be authorized to seek immediate injunctive relief in emergency situations in which severe water pollution constitutes an imminent danger to health or threatens irreversible damage to water quality.

I propose that the federal pollution-control program be extended to include all navigable waters, both inter- and intra-state, all interstate ground waters, the United States' portion of boundary waters, and waters of the contiguous zone.

I propose that federal operating grants to state pollution control enforcement agencies be tripled over the next five years—from $10 million now to $30 million by fiscal year 1975—to assist them in meeting the new responsibilities that stricter and expanded enforcement will place upon them.

* * *

The Secretary of Health, Education and Welfare is today publishing a notice of new, considerably more stringent motor vehicle emission standards he intends to issue for 1973 and 1975 models—including control of nitrogen oxides by 1973 and of particulate emissions by 1975.

* * *

Effective control requires new legislation to correct two key deficiencies in the present law:

A) Testing procedures. Under present law, only manufacturers' prototype vehicles are tested for compliance with emission standards, and even this is voluntary rather than mandatory.

I propose legislation requiring that representative samples of actual production vehicles be tested throughout the model year.

B) Fuel composition and additives. What goes into a car's fuel has a major effect on what comes out of its exhaust, and also on what kinds of pollution-control devices can effectively be employed. Federal standards for what comes out of a car's engine should be accompanied by standards for what goes into it.

I propose legislation authorizing the Secretary of Health, Education and Welfare to regulate fuel composition and additives.

With these changes, we can drastically reduce pollution from motor vehicles in the years just ahead.

* * *

I am inaugurating a program to marshal both government and private research with the goal of producing an unconventionally powered, virtually pollution-free automobile within five years.

I have ordered the start of an extensive federal research and development program in unconventional vehicles, to be conducted under the general direction of the Council on Environmental Quality.

* * *

I propose that the federal government establish nationwide air quality standards, with the states to prepare within one year abatement plans for meeting those standards.

* * *

I propose that designation of interstate air quality control regions continue at an accelerated rate, to provide a framework for establishing compatible abatement plans in interstate areas.

I propose that the federal government establish national emissions standards for facilities that emit pollutants extremely hazardous of health, and for selected classes of new facilities which could be major contributors to air pollution.

* * *

I propose that federal authority to seek court action be extended to include both inter- and intrastate air pollution situations in which, because of local nonenforcement, air quality is below national standards, or in which emission standards or implementation timetables are being violated.

I propose that failure to meet established air quality standards or implementation schedules be made subject to court-imposed fines of up to $10,000 per day.

Many currently used techniques of solid waste disposal remain crudely deficient. Research and development programs under the Solid Waste Disposal Act of 1965 have added significantly to our knowledge of more efficient techniques. The act expires this year. I recommend its extension, and I have already moved to broaden its programs.

I have ordered a redirection of research under the Solid Waste Disposal Act to place greater emphasis on techniques for recycling materials, and on development and use of packaging and other materials which will degrade after use—that is, which will become temporary rather than permanent wastes.

* * *

I have asked the Council on Environmental Quality to take the lead in producing a recommendation for a bounty payment or other system to promote the prompt scrapping of all junk automobiles.

* * *

I propose full funding in fiscal 1971 of the $327 million available through the Land and Water Conservation Fund for additional park and recreational facilities, with increased emphasis on locations that can be easily reached by the people in crowded urban areas.

I propose that we adopt a new philosophy for the use of federally owned lands, treating them as a precious resource—like money itself—which should be made to serve the highest possible public good.

* * *

By executive order, I am directing the heads of all federal agencies and the Administrator of General Services to institute a review of all federally owned real properties that should be considered for other uses. The test will be whether a particular property's continued present use or another would better serve the public interest, considering both the agency's needs and the property's location.

* * *

Special emphasis will be placed on indentifying properties that could appropriately be converted to parks and recreation areas, or sold, so that proceeds can be made available to provide additional park and recreation lands.

* * *

The task of cleaning up our environment calls for a total mobilization by all of us. It involves governments at every level; it requires the help of every citizen. It cannot be a matter of simply sitting back and blaming someone else. Neither is it one to be left to a few hundred leaders. Rather, it presents us with one of those rare situations in which each individual everywhere has an opportunity to make a special contribution to his country as well as his community.

POWER AND FUEL RESOURCES

(*Continued from page 336*)

Until the end of the century, the decisions about heat and carbon dioxide release will be based on how much change we are willing to accept. But it is possible that these pollutants can drastically and permanently change our environment during the next century, so it is necessary to consider these consequences now.

In summary, it appears that if we are willing to initiate and sustain the effort necessary to develop the technology, we have enough fuel for our power needs and we can control all the consequent pollutants except heat and carbon dioxide. Considering the possible dire consequences of these pollutants, however, we should ask ourselves if meeting the present demands for more power is worth the risk.

GOVERNMENT'S HISTORICAL ROLE IN CONSERVATION

(*Continued from page 327*)

low-cost hydroelectric power, produced fertilizers, connected a series of navigable rivers and lakes, and alleviated floods and soil erosion. The Authority worked in close cooperation with the residents of the valley and was considered a model of government economic and social planning. Other federally built, owned and operated hydroelectric developments under the New Deal—the Grand Coulee and Bonneville dams on the Columbia, Boulder dam on the Colorado, and the Fort Peck dam on the upper Missouri— were valuable in themselves but did not attempt to coordinate so many activities as the T.V.A.

Conservation measures were slowed down after 1940 because of World War II, the cold war military expenditures following World War II, and the phenomenal prosperity of the country, which induced a national euphoria and diverted Americans from increasingly pressing domestic problems. By the late 1960's, however, new forms of spoliation had become so acute that the public was aroused to the need to extend the older conservation measures and to tackle the new problems which threatened a healthy environment.

OCEAN RESOURCES AND POLLUTION

(*Continued from page 354*)

overpopulation can be dealt with only by directing ourselves towards developing a new societal value system which recognizes the need for birth control and an environment free from pollution. The main obstacle to such reforms is man himself—his traditional notions of growth, sovereignty, individualism and time. Man is ever the optimist, believing that new technology will solve such problems. Unfortunately, the leaders of our technology seldom share this optimism. Several leading scientists at the 1969 American Association for the Advancement of Science meetings in Boston estimated that the earth can probably support 6 billion people, but only if pollution is abated and population is finally limited. However, this gives us only until the year 2000—only 30 years—for man to change his priorities. By that time the world's population will again have doubled.

OPTIMUM POPULATION AND ENVIRONMENT

(*Continued from page 359*)

and location of new industry. Citizens will be doing industry and society a favor by establishing tough pollution standards and requiring advance waste treatment because it is much cheaper to engineer and internalize the costs of complete waste treatment, water and air recycling at the beginning than to take action later and also pay for repairing a damaged environment. There is no longer a need nor excuse for "dirty" industries that pollute and pay low wages. Any state can now attract industries that have the resources to pay good wages and the public conscience to do what is necessary in waste management.

In summary, our microcosm study makes a case for basing the optimum population on total space requirement and not on food as such. The world can feed more "warm bodies" than it can support high quality human beings.

WHERE THE WATER IS

(*Continued from page 328*)

Water quality is affected by more than the presence or absence of man-deposited pollution. The salinity of the soil is of major importance; some water in the West cannot be used for domestic purposes because of high natural salinity (some of this salt comes from sedimentary rock which retains brine from former marine environments in early geologic time).

Watershed lands must be managed with optimum care and technique. Erosion, the loss of the spongy soil when forests are cut, and the dissolved solids which return to the water table from irrigated farms all damage or diminish the supply of groundwater.

It is estimated that by the year 2020, some 40 per cent of our water will be processed ocean water. While some plants are already in operation and several techniques are under study, the related question of ocean pollution will enter into these calculations.

FRESH WATER: A DIMINISHING SUPPLY

(*Continued from page 329*)

oil facilities with the enactment into law of the Water Quality Improvement Act of 1969, which stipulates that the owner is responsible for the costs of cleaning up a spill.

This new law also establishes the principle that any facility licensed by a federal agency must also comply with state water quality standards. This would be especially applicable, for instance, in the case of an atomic power plant licensed by the Atomic Energy Commission. The states will thus have leverage to control the amount of thermal pollution. The A.E.C., with its emphasis on development of atomic facilities, offers a good demonstration that agencies charged with the development of a resource or industry should not also be responsible for regulating pollution resulting from that industry. Development too often wins out at the expense of the environment in such cases.

There is evidence that mounting public concern about pollution supports efforts to finance the water quality program. Congress, resisting arguments that there was not sufficient money available, appropriated $800 million for the water pollution program in the fiscal year 1970. Our 1966 legislation authorized $3.4 billion over a four-year period to assist in the construction of municipal waste treatment plants, but only $1.2 billion has been appropriated. Fiscal 1971 is the last year of the five-year program authorized by Congress in 1966, and $1.25 billion has been authorized. At the least, this level is necessary if any significant progress is to be made.

For the next five years, I believe we must raise the level of federal participation. Legislation I am proposing would authorize $2.5 billion a year in federal grants for the next five years, which would be the federal share of $25 million worth of treatment facilities. In the historical development of water pollution control, the Water Quality Act of 1965 added the concept of water quality standards, for the first time setting levels of pollution control. Previous significant legislation was passed in 1948 and 1956. The 1948 law initiated federal financial and technical assistance for water pollution control and set up a modest form of federal enforcement. The 1956 law strengthened enforcement procedures somewhat.

Our 1965 legislation set up the Federal Water Pollution Control Administration, now in the Department of the Interior, to coordinate activities relating to water pollution. The 1965 law also enunciated the principle that Congress intended the law "to enhance the quality and value of our water resources and to establish a national policy for the prevention, control and abatement of water

pollution." This principle has proved important in preventing the degradation of waters now relatively clean.

Under the 1965 legislation, the states are required to establish water quality standards for interstate waters in connection with their use for drinking water, propagation of fish and wildlife, recreational purposes and agricultural, industrial and other uses. The state standards, accompanied by an implementation plan, are then subject to approval of the Secretary of the Interior. If the states do not comply, the Secretary has the power to promulgate standards for the state.

The legislation I am now proposing extends water quality standards to all navigable waters. This new legislation would cover almost all the nation's waterways and put additional emphasis on planning for entire river basins. The bill would authorize a federal share of 60 per cent of the cost of the treatment works located in a basin designated by the Secretary of the Interior. Forty per cent of the cost would be shared by the states, communities and industries located in the basin area.

I believe that the water quality standards approach, if coupled with effective enforcement, offers the best approach to maintaining and improving the quality of our waterways. Particularly, it allows for differing standards, to take into account differences in present water quality and the protection of those streams and lakes which now have low pollution levels.

On the question of enforcement, one procedure calls for conferences with state and federal officials involved in a case, followed by a public hearing involving alleged polluters and then possible court action. Contrary to congressional intent, enforcement has largely been conducted through private conferences with polluters; there has been a reluctance to use court action and to involve the public. My proposed legislation drops the conference approach in favor of a more effective, quicker enforcement of standards.

Responsibilities affecting water pollution also are scattered throughout the federal bureaucracy. The Federal Water Pollution Control Administration, with general responsibility for water quality, is in the Department of the Interior. However, the agency which monitors the quality of drinking water, the Bureau of Water Hygiene, is in the Department of Health, Education, and Welfare. The control of pesticides is under the jurisdiction of the Department of Agriculture, which also actively promotes the use of pesticides to increase agricultural production.

Responsibility for radiological protection and thermal pollution controls falls mainly on the Atomic Energy Commission. The Army Corps of Engineers, not notable for its record of environmental concern, is responsible for control of most industrial discharges into the navigable waters. The corps dredges these waters and authorizes the dumping of dredging spoil into them. Congress also has given authority to the Department of Housing and Urban Development and the Farmers Home Administration in the Department of Agriculture to make grants and loans for the construction of sewerage systems.

Each of these agencies has control of a fragment of the water problem, preventing any unified approach to pollution prevention. I am therefore proposing an independent watchdog agency, the Environmental Quality Administration. It would bring under one agency, unconnected with any Cabinet department, the various aspects of water pollution as well as air pollution and solid waste disposal, the two other major environmental problems. Since these various kinds of pollution are so closely interrelated, the E.Q.A. would provide the kind of unified approach we must have.

In approaching our task, the greatest question is not the availability of the necessary technology but the willingness to spend the necessary money and to enforce anti-pollution laws vigorously.

Ideally, we must strive for advanced water treatment plants in all communities, which would remove phosphates, nitrogen and other complex pollutants as well as suspended solid and degradable organic waste. Too many American municipalities are far from

ESTIMATED WATER USE AND PROJECTED REQUIREMENTS, UNITED STATES

(Million gallons daily)

Type of use	Used 1965	Projected requirements 1980	2000	2020	Used 1965	Projected requirements 1980	2000	2020
	Withdrawals, some returned to source				*Consumptive use*			
Rural domestic	2,351	2,474	2,852	3,334	1,636	1,792	2,102	2,481
Municipal (public-supplied) .	23,745	33,596	50,724	74,256	5,244	10,581	16,478	24,643
Industrial (self-supplied) ...	46,405	75,026	127,365	210,767	3,764	6,126	10,011	15,619
Steam-electric power:								
Fresh	62,738	133,963	259,208	410,553	659	1,685	4,552	8,002
Saline	21,800	59,340	211,240	503,540	157	498	2,022	5,183
Agriculture:								
Irrigation	110,852	135,852	149,824	160,978	64,696	81,559	89,964	96,919
Livestock	1,726	2,375	3,397	4,660	1,626	2,177	3,077	4,238
Total	269,617	442,626	804,610	1,368,088	77,782	104,418	128,206	157,085

Source: *The Nation's Water Resources* (Wash., D.C.: U.S. Government Printing Office, 1968).

achieving this advanced level of treatment.

However, attempts to upgrade the treatment of already-discharged wastes are not the only course we should be pursuing. We must ask whether the present volume of use of phosphorous-based fertilizers and detergents, as well as pesticides and weed-killers, is worth the price we pay in pollution. There should be consideration of requiring, on a reasonable timetable, a change to products with less harmful chemical bases.

The layman must inform himself to be effective in bringing pressure on government officials, in working toward abatement of water pollution. In Washington, we have tried to provide for public participation in combating water pollution, but most standard-setting is done at the state level, and citizens' groups exerting leverage with state officials can sometimes be highly effective. Setting air quality standards has demonstrated that effectiveness. Industrial polluters tend to have more habitual access to government officials, and environmentally concerned citizens must often fight to be heard.

Toward this end, I am recommending amendment of the Air and Water Quality Acts so that concerned citizens may bring class action suits to enforce the standards.

There has been much talk about population growth as the root cause of pollution. While a cutback in population growth may be desirable, it is not the sole answer. If our population remained absolutely static for the next 20 years, that alone would not clean up Lake Erie or the Ohio River. We must decide that clean water is a necessity and that we are willing to pay for it.

Many of us tend to think of pollution only in terms of large factories or farms. But there is more to it than that. Our life style influences pollution. Our desires and buying practices set many of society's priorities. Power companies tell us that the growing demand for electricity makes new generating plants absolutely necessary. New plants may be accompanied by thermal pollution problems and perhaps air pollution problems as well. But is the continual high increase in demand inevitable? Are citizens concerned enough about the environment to get along with fewer electric appliances, to use less water, to separate their home wastes to facilitate easier reuse of wastes?

Realizing that our water and other resources are not limitless, that our environment is threatened, have we the will to solve these problems? We find ourselves on a frightening frontier—not one to be readily conquered, but one which could conquer us.

FOREST LANDS AND WILDERNESS

(*Continued from page 348*)

both as monitors and as ameliorating agents. Moreover, the unlimited supply of pure air has always been taken for granted; but the only reason the earth's atmosphere contains oxygen for us to breathe is that oxygen is constantly given off by green plants. This means we cannot continue to allow forests to be replaced by jetports, freeways, shopping centers, barren suburbias and factories. It also means that management and the conservation of air must be implicit in the new science of environmental forestry.

Third, forest management needs to eliminate its own waste.

For generations, logging has been a destructive practice at best. About half the wood cut is left in the forest, then half the remainder is discarded in processing. Through research, scraps now go into fibreboard and particleboard, and promising work is being done on the utilization of limbwood and tops of trees which are now useless. But this is only the beginning.

As part of environmental forestry, the Forest Products Laboratory at Madison, Wisconsin, has been assigned the mission of helping lessen air and water pollution. This is based on recognition that woodpulp mills have been guilty of depositing wood residues and by-products in streams or the atmosphere; that air often is polluted by the burning of logging slash and sawmill residues, and that even the disposal of cast-off wood products at municipal dumps creates pollution. The common denominator is incomplete utilization. Thus scientists have set out to study the possibility of recovery of cellulose from mill effluents and to look for ways to use, rather than burn, logging slash, slabs and sawdust.

Fourth, although management has come a long way in the national forests and industrial holdings, it has hardly begun on the small woodlots which comprise three-fifths of the nation's potential timber supply.

The National Association of State Foresters has urged federal participation of 50 per cent of annual state expenditures in order to stimulate owner incentive for better management. There is a need to bring scientific management to more watershed lands; to increase wildlife concern in forest management plans; to expand the recreation business on private lands; to furnish technical and financial assistance to forest cooperatives, and to offer small woodland owners long-term loans at low interest rates in order to insure both softwood and hardwood for the future.

Above all, no landowner, large or small, should be able to control land use without regard for what his actions do to others. Ownership must be recognized as a trust to be exercised in the interests of other people and the quality of the total human environment. For land is an integral part of all life and its resources remain part of the environment.

Perhaps the first rule to establish clearly for those who use and administer the land is that the economic parts of the forest life-community will not function without elements which lack commercial value but which are essential to its well-being. When this is clearly defined, we can proceed to sustain healthy forests for many years to come.

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THE MONTH IN REVIEW

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zone. Intense fighting also flares along the Cambodian border.

Apr. 10—A South Vietnamese battalion succeeds in reaching a besieged U.S. camp at Dakseang after 10 days of fighting.

Apr. 12—A second U.S. Special Forces camp is under heavy siege by North Vietnamese troops at Dakpek near the Laotian border.

Apr. 15—South Vietnamese and Cambodian troops destroy a North Vietnamese base in Cambodia.

Apr. 16—The U.S. combat death toll for the past week reaches 141—the highest since September, 1969.

Apr. 27—Hanoi Radio broadcasts a statement by leaders of North Vietnam and Communist representatives from Laos and South Vietnam supporting deposed Cambodian Chief of State Norodom Sihanouk in his opposition to the U.S. forces in Indochina. A 2,000-word declaration denounces the U.S. as an imperialist aggressor.

BRAZIL

Apr. 5—Would-be kidnappers fail to capture U.S. consul Curtis C. Cutter. Cutter's car strikes one of the attackers. A machine-gun bullet strikes Cutter in the shoulder as he escapes the ambush.

CAMBODIA

(See also *U.S., Foreign Policy*)

Apr. 2—486 political prisoners are released by the new Cambodian government. They had been jailed by deposed Chief of State Norodom Sihanouk.

Apr. 7—Vietcong attacks against Cambodian border points increase.

Apr. 8—The *Columbia Eagle* is released by the Cambodian government and sails for the Philippines. (See *Current History,* May,1970, p. 312ff.)

Apr. 10—Heavy crossfire between Cambodian and North Vietnamese troops at the Cambodian border village of Prasot results in the death of 89 Vietnamese civilians.

Apr. 14—In a statement broadcast from Pnompenh, Premier Lon Nol appeals for arms from any country willing to supply them.

Apr. 15—Hundreds of Vietnamese bodies float down the Mekong River, their hands tied behind them. The Cambodian government has been directing an anti-Vietnamese campaign recalling ancient feuds. There are thought to be about 600,000 Vietnamese in Cambodia.

Apr. 17—Cambodian soldiers shoot 100 Vietnamese civilians, including 30 children, in a provincial capital 50 miles from Pnompenh.

Military spokesmen say that during the past 2 weeks the Vietcong has doubled the area it controls in Cambodia.

Apr. 19—The town of Saang, 20 miles south of Pnompenh, is seized by Vietnamese Communist troops.

Apr. 21—An appeal for arms and for the use of Cambodian mercenaries now in South Vietnam is sent by Premier Lon Nol to U.S. President Richard Nixon.

Apr. 23—Sources in Cambodia report the receipt of arms sent by U.S. forces in South Vietnam. Washington sources say that captured Soviet-designed AK-47 automatic rifles have been turned over to Cambodia. (See also *U.S., Foreign Policy.*)

Apr. 26—A proposal for an Asian conference to settle the fighting in Cambodia made by Indonesian Foreign Minister Adam Malik is rejected by North Vietnam and Communist China.

CANADA

Apr. 8—The government introduces legislation applying Canadian pollution regulations to shipping in Arctic waters within 100 miles of the Canadian shore.

Apr. 30—Robert Bourassa's pro-federalist Liberal party wins 71 out of 108 seats in the French Canadian Provincial Assembly, defeating Premier Jean Jacques Bertrand's National Union party.

CHAD

Apr. 27—It is reported in Paris that in response to a question raised by Centrist deputy François Mitterand in the National Assembly, the French government has admitted that 1,538 French military men are deployed in Chad to help President François Jombalbaye put down continuing guerrilla fighting.

CHINA, PEOPLE'S REPUBLIC OF (Communist)

Apr. 25—The launching of China's first space satellite is announced by the Chinese news agency *Hsinhua.*

CHINA, REPUBLIC OF (Nationalist)

Apr. 24—Chiang Ching-kuo, eldest son of Generalissimo Chiang Kai-shek, escapes death when a policeman deflects the aim of a Taiwanese nationalist who was shooting at Chiang in New York City. (See also *U.S., Foreign Policy.*)

COLOMBIA

Apr. 19—After an early count of ballots for the presidential election, former dictator Gustavo Rojas Pinilla claims victory. He ran on a populist platform. His opponents are Misael Pastrana, Belisario Betancur and Evaristo Sourdis.

Apr. 20—Further counting shows the lead for the presidency swinging to Pastrana, the nominee of the governing coalition of Liberal and Conservative parties. Rojas claims fraud in the counting.

Apr. 21—Martial law is declared following street disorders by the followers of Rojas.

Apr. 26—Official tallies of the votes show Pastrana the victor in the presidential election. Rojas insists that he has won.

CUBA

Apr. 19—On Havana Radio, Premier Fidel Castro announces that a group of Cuban exiles has landed in Cuba and that 4 Cuban soldiers have been killed in the first clash. Fighting is said to continue.

Apr. 27—The Cuban government announces the capture of the last of the exile guerrilla fighters who landed in the country on April 17. The guerrillas were under the leadership of Vincente Mendez, a member of an exile group called Alpha 66 which is based in Miami.

DAHOMEY

Apr. 3—The military government announces that the general elections, which were suspended March 28 after incidents of violence, have been annulled. (See *Current History,* May, 1970, p. 313.)

DOMINICAN REPUBLIC

Apr. 2—The leaders of 7 non-Communist parties announce they will boycott the general elections scheduled for May 16 unless President Joaquin Balaguer resigns. Balaguer has announced his determination to run for reelection, and the opposition demands that he transfer his presidential powers to the Chief Justice of the Supreme Court because of the prevailing climate of terror in the country.

Apr. 6—All urban public schools are closed by Balaguer to reduce student agitation against his reelection campaign.

FRANCE

(See also *Chad*)

Apr. 1—The Cabinet proposes a general conference on Indochina to advance the chances for peace.

GAMBIA

Apr. 23—Gambia becomes a republic within the British Commonwealth. Former Prime Minister Dauda Kairaba Jawara becomes the first President.

GERMANY, FEDERAL REPUBLIC OF (West)

Apr. 6—The government orders most of its diplomatic staff in Guatemala to return home following the murder of the West

German Ambassador to Guatemala, Karl von Spreti. (See also *Guatemala.*)

Apr. 11—West German Foreign Minister Walter Scheel accompanies the body of slain diplomat Karl von Spreti from Guatemala to Bonn.

Apr. 12—Chancellor Willy Brandt returns from Washington where he held talks with President Richard Nixon on European affairs. (See also *U.S., Foreign Policy.*)

GREECE

Apr. 2—Five newspaper executives and a former Cabinet minister are given prison sentences and heavy fines for publishing an interview calling for the restoration of democracy in Greece.

Apr. 10—In a televised news conference, Premier George Papadopoulos says he is easing martial law but that the country is not yet ready for democracy.

Apr. 12—A military court sentences 27 defendants to long prison terms for sedition.

Apr. 13—The government permits composer Mikis Theodorakis to leave prison and fly to Paris for medical treatment.

Apr. 15—Fifteen member nations of the Council of Europe accuse Greece of torturing political prisoners. France and Cyprus abstain from the resolution condemning the military government.

Apr. 18—The government sends 40 political prisoners into exile on an isolated island.

GUATEMALA

Apr. 1—A note is received from West German Ambassador Karl von Spreti who was kidnapped March 31.

Apr. 2—The government refuses to meet the ransom terms of guerrillas who captured von Spreti; the kidnappers are demanding the release of 17 political prisoners in return for von Spreti's release.

Apr. 3—Following refusal of their first demands, the kidnappers ask release of 25 political prisoners and the payment of $700,000 as ransom.

Apr. 5—Von Spreti's body is found 10 miles from the center of Guatemala City.

Apr. 8—Right-wing partisans kill a Guatemalan Communist in revenge for the death of Karl von Spreti.

HAITI

Apr. 24—Three of Haiti's 5 Coast Guard ships are siezed by rebels and fire shells at the capital city of Port-au-Prince. Damage is light.

Apr. 26—Haitian President François Duvalier is in control of the government despite the revolt of members of the Coast Guard who shelled the capital.

INDONESIA

Apr. 27—Negotiators for the Indonesian government and for several Western countries agree on a schedule for repayment of Indonesia's foreign debts over a period of 30 years. The debt, incurred under the rule of President Sukarno from 1949 to 1966, amounts to some $1.7 billion.

ISRAEL

(See *Intl, Middle East Crisis*)

ITALY

Apr. 10—The center-left coalition Cabinet of Premier Mariano Rumor wins a vote of confidence in the Senate by a vote of 167 to 117.

JAPAN

(See also *South Korea*)

Apr. 5—The Japan Air Line jet that was hijacked to North Korea March 31 returns to Tokyo with its 3 crew members and Deputy Minister of Transportation Shinjiro Yamamura, who flew from Seoul to North Korea as a voluntary hostage.

Apr. 18—The Trade Office in Tokyo announces that talks between Japan and Communist China on renewal of a semi-official trade pact have resulted in an agreement in principle.

JORDAN

(See also *Intl, Middle East Crisis*)

Apr. 15—Palestinian commandos and students attack U.S. offices and the embassy. They are protesting the proposed visit of Joseph Sisco, U.S. Assistant Secretary of State for Near Eastern Affairs. (See also *U.S., Foreign Policy.*)

Apr. 17—The recall of U.S. Ambassador Harrison Symmes is requested by King Hussein, who is angered at Sisco's decision to avoid Jordan during his trip to the Middle East.

KOREA, PEOPLE'S DEMOCRATIC REPUBLIC OF (North)

(See also *South Korea, Japan*)

Apr. 5—Chinese Premier Chou En-lai arrives in Pyongyang for conferences with North Korean Premier Kim Il Sung and President Choi Yong Kun.

KOREA, REPUBLIC OF (South)

(See also *Japan*)

Apr. 1—The hijacked Japan Air Lines plane remains in Seoul airport. Efforts to fool the hijackers fail to convince them they were landed in North Korea. The sword-waving student hijackers release 23 passengers—women and children and an elderly man—but hold the crew and other male passengers.

Apr. 2—Japanese Deputy Transportation Minister Shinjiro Yamamura offers to be a hostage for the remaining passengers and to accompany the plane to North Korea where the students demand to be taken.

Apr. 4—The student hijackers release 99 passengers and 4 stewardesses in exchange for Yamamura. The plane flies to North Korea.

LAOS

Apr. 4—Heavy fighting continues between North Vietnamese and Laotian troops at Sam Thong base 83 miles northeast of the capital of Vientiane.

Apr. 9—The government replies to Pathet Lao peace proposals by stating its readiness to negotiate but refusing to ask the U.S. to stop bombing in Laos.

LEBANON

Apr. 18—Students stone the U.S. embassy and the American University as Joseph Sisco confers with Lebanese government officials.

RHODESIA

Apr. 10—The first national elections under the new republican constitution give the Rhodesian Front party of Prime Minister Ian Smith all 50 of the seats reserved for whites. 8 other seats are won by representatives of black parties.

Apr. 13—The first Cabinet under the new republican constitution is sworn in.

Prime Minister Smith says Rhodesia will limit the spending on the education of black Rhodesians to 2 per cent of the gross domestic product. Church officials say this will mean the closing of most missionary schools, where more than half the black students receive their primary education.

Apr. 14—Prime Minister Smith appoints Clifford Dupont as first President of the Republic.

Apr. 28—At the close of an all-day meeting, the leaders of 11 Christian church denominations agree unanimously to refuse to obey the new land tenure law that prevents people of one race from worshiping on land reserved for another race. The Roman Catholic Archbishop and 4 Roman Catholic bishops have already declared their intention to defy the law. The churches will refuse to register as "voluntary organizations."

Apr. 29—Bishops of the Catholic church tell the government that if the act to bar interracial worship is not declared null they will close all church schools, orphanages, old age homes and other institutions of social welfare in the country.

SPAIN

Apr. 2—In a letter to a major Spanish newspaper, Generalissimo Francisco Franco rejects the possibility of liberal reforms in government affairs.

SYRIA

(See *Intl, Middle East Crisis*)

TRINIDAD

Apr. 21—A state of emergency is proclaimed after an outbreak of looting and rioting in Port of Spain. Black power rebels in the army clash with loyal troops.

Apr. 22—The U.S. sends mortars and machineguns to Trinidad at the request of the government.

Apr. 23—Anti-government activists are being rounded up as the government holds talks with rebel forces.

Apr. 24—The government reports that control has been restored and calm prevails. U.S. warships, which have been cruising in the vicinity of Trinidad to evacuate American citizens if the rioting spread, are ordered away from the island.

U.S.S.R.

Apr. 13—In a nationwide television program, party leader Leonid Brezhnev criticizes labor productivity, poor economic management and shortages of consumer goods.

Apr. 14—Brezhnev tells a television audience that the Soviet Union would welcome a reasonable agreement with the U.S. on strategic arms limitation.

Apr. 21—At a ceremony marking the Lenin Centennial at the Kremlin, Brezhnev urges economic reforms.

Apr. 22—Premier Aleksei Kosygin closes the Lenin Centennial ceremonies with a pledge that the U.S.S.R. will guard the peace and aid the struggle against imperialism. The brevity of his speech adds to rumors that Brezhnev is assuming primary leadership.

Apr. 27—The Soviet press and radio issue firm rejections of a proposed Asian conference to deal with the crisis in Cambodia. Statements are critical of Indonesian Foreign Minister Adam Malik, who initiated the proposal.

The Soviet news agency *Tass* announces that the U.S.S.R. has successfully fired a rocket placing 8 unmanned satellites in orbit.

Legislation to forbid pollution and to conserve water is announced by the government. Criminal and administrative penalties will be levied against violators.

Apr. 30—*Tass,* the Soviet news agency, condemns U.S. and South Vietnamese intrusion into Cambodia as "a gross violation" of the Geneva agreements.

U.A.R.

(See *Intl, Middle East Crisis*)

UNITED KINGDOM

Great Britain

Apr. 7—Prime Minister Harold Wilson pledges to keep British troops in Northern Ireland as long as needed.

Northern Ireland

Apr. 4—New bombings in Belfast injure 4 people as rioting continues.

Apr. 16—Protestant militant leader Ian Paisley wins a by-election to a seat in the Northern Ireland Parliament. Paisley ran on a platform of "stop the sellout," charging that the government has been too generous to the Catholic minority.

UNITED STATES

Campus Unrest

Apr. 28—It is reported from New Haven that units of the National Guard have been alerted for possible deployment May 1 if disorder accompanies a rally planned to support 8 members of the Black Panther party facing murder and kidnapping trials in New Haven. The New Haven Black Panther Defense Committee is said to expect more than 20,000 people at the rally, including several thousand students from the Boston area.

A student strike at Yale University in

support of the Panthers continues into its 7th day.

Apr. 30—At the request of Connecticut Governor John Dempsey, federal troops are flown to New England. The 4,000 paratroopers and marines are posted in Massachusetts outside the borders of Connecticut ready to move into New Haven if the demonstration in support of the Black Panthers should get out of hand.

Some hundred students are injured at Ohio State University as demonstrators clash with National Guardsmen. Students are protesting the refusal of the administration to accede to demands for more black student admissions and an end to R.O.T.C.

Civil Rights

April 1—Officials of the National Association for the Advancement of Colored People contend that the New York Plan is a "hoax" that will not really eliminate job discrimination in the building trade unions in New York. (See *Current History,* May, 1970, p. 316.)

Apr. 2—Delegates to a southeast Indian conference charge that the federal government discriminates against Indians in job promotions. Delegates include members of the Seminole, Miccosukee, Choctaw and Cherokee tribes.

Apr. 5—Governor Claude R. Kirk, Jr., of Florida assumes control of the Manatee County schools and orders pupils to ignore the Supreme Court-ordered integration plan.

Apr. 7—A federal district judge orders that the control of the Manatee County schools be returned to local officials and that integration plans go into effect by April 9.

The Justice Department brings suit to prevent the payment of Mississippi state funds to teachers in private segregated schools.

Apr. 8—Governor Kirk again seizes control of the Manatee County schools in Florida; he suspends the members of the local school board and dismisses the school superintendent.

Apr. 11—In a 27-page analysis of President Richard Nixon's March 24 statement on school desegregation, the Commission on Civil Rights says: "The problems of racial isolation in the nation's schools cannot be resolved solely through cautious adherence to a narrow construction of existing case law."

Federal District Judge Ben Krentzman orders Florida's Governor Kirk to cease disobeying the judge's desegregation order or to pay a fine of $10,000 a day.

Apr. 12—In a television speech, Governor Kirk of Florida says that he will reinstate the Manatee County school board and the county school superintendent and orders them to put the court-ordered racial integration plan into effect April 14. (See also *U.S., Supreme Court.*)

Apr. 13—The National Education Association expels its Mississippi affiliate, charging that the group refuses to merge with a black teachers' organization.

Apr. 15—The Labor Department announces that it has rejected a minority hiring program worked out by the Maritime Administration with the Newport News Shipbuilding and Dry Dock Company. The department finds the plan inadequate.

Apr. 27—U.S. Commissioner of Education James E. Allen, Jr., says that he will continue to work for the elimination of segregation in both de facto and de jure situations. This goes beyond the policy stated by President Nixon and Secretary of Health, Education and Welfare Robert Finch.

Economy

Apr. 10—The Labor Department reports that the unemployment rate rose again in March to 4.4 per cent.

Apr. 22—The Labor Department announces consumer price increases of 0.4 per cent in March. This is a slowdown in the rate of increase.

Apr. 27—Under pressure of continuing price

increases and reduced corporate profits, the stock market dips to its lowest level since President John Kennedy was assassinated in November, 1963.

Apr. 28—Paul McCracken, chairman of the President's Council of Economic Advisers, tells an audience of financial analysts that the inflation shows signs of moderating and that the economy is quickening its pace.

Foreign Policy

Apr. 3—Robert J. McCloskey, State Department spokesman, denies that talks with Japan on a negotiated agreement on textile imports have been broken off. "Background" remarks by officials yesterday indicated that the chance of successful negotiation in this field was "very slim."

Apr. 4—West German Chancellor Willy Brandt arrives in the U.S. He will confer with President Richard Nixon next week.

Apr. 7—It is reported by *The New York Times* that a committee chaired by John McCloy which is serving as a policy adviser to the Arms Control and Disarmament Agency has suggested that the U.S. propose to the U.S.S.R. an immediate and mutual moratorium on further deployment of strategic weapons.

Apr. 8—Assistant Secretary of State for Near Eastern and South Asian Affairs Joseph J. Sisco leaves Washington to visit Israel and Arab capitals before attending a conference of U.S. ambassadors in Iran on April 20.

Apr. 9—State Department spokesman Robert McCloskey says the U.S. will not recognize Canada's claim to regulate U.S. vessels on the "high seas" in the Arctic seas. He makes the statement in response to legislation introduced to Canada's Parliament yesterday. (See *Canada.*)

Voting 72 to 6, the Senate adopts a Republican-sponsored sense-of-the-Senate resolution urging the President to "propose to the Soviet Government an immediate suspension by the United States and the Soviet Union of the further deployment of all offensive and defensive nuclear strategic weapons systems, subject to national verification of other measures of observation and inspection as may be appropriate."

Apr. 10—Senator Frank Church (D., Idaho) suggests that the Agency for International Development (AID) should be closed; he declares that the U.S. aid program in Latin America is a "net loss."

In a speech to the National Press Club in Washington, D.C., West German Chancellor Willy Brandt urges Americans to support a continuing U.S. military presence in Europe.

The Senate Foreign Relations Committee votes to repeal the 1964 Gulf of Tonkin Resolution and unanimously adopts a resolution to repeal the 1957 Middle East resolution. Both resolutions authorize military action by the U.S. and both provide for repeal by joint action of both houses of Congress with no requirement of Presidential approval.

Apr. 11—Ronald Ziegler, White House press secretary, declares that the administration has no plans "to cut back in Europe" after the expiration of its standing commitment to maintain forces at the current level through June 30, 1971.

Apr. 13—The master of a Soviet tanker is arrested in the Gulf of Alaska by the U.S. on charges of spilling a mile-long oil slick.

Apr. 14—Canada receives a formal protest from the U.S. against a move to establish Canadian jurisdiction over international waters in the Arctic. (See also *Canada.*)

Danish Premier Hilmar Baunsgaard is welcomed at the White House by President Richard Nixon.

Defense Secretary Melvin Laird and Australian Minister of Defense Malcolm Frazer jointly announce that because of technical problems there will be a further delay in the delivery of 24 F-111's scheduled for delivery to Australia by the U.S.

Apr. 15—The State Department announces the release of the Soviet tanker master after the Soviet Embassy pays a $1,500 fine to

settle the charges of pollution in the Gulf of Alaska.

Apr. 16—The State Department discloses that the U.S. has received a specific request for arms and military supplies from Cambodia.

The State Department announces that Joseph Sisco will not visit Jordan on his Middle Eastern tour because of anti-U.S. demonstrations there yesterday.

As strategic arms limitation talks reconvene in Vienna, it is disclosed in Washington that the President has decided to work toward a comprehensive limitation on strategic weapons, rather than a weapon-by-weapon approach. (See also *Intl, Disarmament.*)

Apr. 18—Secretary of State William Rogers declares that the U.S. is looking into Soviet suggestions that a new Geneva conference on Indochina might prove fruitful. (See *Intl, U.N.*)

Apr. 21—Nationalist China's Deputy Premier Chiang Ching-kuo tells Secretary of State Rogers that friendly U.S. gestures toward Communist China are not in the interest of peace in Asia.

Apr. 22—In a 15-minute television address, the President promises to withdraw 150,000 more men from Vietnam over the next year; he asks North Vietnam to undertake serious negotiation.

The administration discloses that it has agreed to send several thousand rifles to Cambodia, but has cautioned the Cambodians against "inflated expectations" of further U.S. aid.

Apr. 24—White House press secretary Ronald Ziegler tells reporters that the Vietnamese offensive in Cambodia is "a foreign invasion of a neutral country which cannot be considered in any way a pretense of a civil war."

Apr. 27—Appearing before the Senate Foreign Relations Committee meeting in closed session, Secretary of State Rogers discusses the crisis in Cambodia and suggests to the Senators that the administration has authority to send limited amounts of military supplies to Cambodia without congressional approval. Committee chairman J. William Fulbright (D., Ark.) tells reporters after the meeting that committee opposition to the sending of military aid to Cambodia under the present circumstances is "virtually unanimous."

Apr. 29—President Nixon orders a full and immediate evaluation of reports that Soviet pilots are flying planes in central Egypt.

A number of Senators, including some who have supported President Nixon's "Vietnamization" of the war, voice anger and disappointment over the administration's move to expand U.S. involvement in Cambodia.

U.S. technical advisers, combat advisers, tactical air support and medical evacuation teams are being sent from South Vietnam into Cambodia, according to an announcement from the Defense Department.

Apr. 30—President Nixon tells a national television audience that he has ordered U.S. troops into action in Cambodia to attack what he terms "the headquarters for the entire Communist military operation in South Vietnam." The President briefed some 40 congressional leaders before his speech. (See also *Cambodia.*)

Government

Apr. 1—In a letter to Republican Senator William B. Saxbe of Ohio, released today, President Nixon charges that the appointive powers of the President are threatened by those Senators who are trying to defeat his nomination of Judge G. Harrold Carswell to the Supreme Court.

Apr. 2—Federal district court Judge George L. Hart announces that the government has agreed to dismiss contempt of court complaints against 3 officers of the Professional Air Traffic Controllers Organization; they have promised to try to get "sick" controllers back to work. (See also *Labor.*)

The President asks Congress to raise the Veterans Administration's health care bud-

get by $65 million to enlarge medical programs for veterans of the war in Vietnam.

Seven postal unions and the administration agree on a 2-step, 14 per cent pay increase for postal workers.

Twelve members of the Weathermen (an extreme underground faction of the Students for a Democratic Society) are indicted in Chicago on charges of conspiracy and violation of the federal anti-riot act; the F.B.I. is searching for them.

Apr. 3—President Nixon asks Congress to raise the postal rate for first-class mail from 6¢ to 10¢, to pass other postal increases and to accelerate collection of estate and gift taxes to finance federal employee pay rises.

The President signs the Water Quality Improvement Act of 1970, providing stiffer penalties for oil spills and extending the liability for cleaning up such spills.

It is reported in Washington that the Department of Health, Education and Welfare has disclosed that in 39 states, welfare systems fail to meet federal standards in full.

Apr. 8—Voting 51 to 45, the Senate refuses to confirm the nomination of G. Harrold Carswell as a Justice of the Supreme Court. (See also *Current History*, May, 1970, p. 318.)

Apr. 9—Charles H. Rogovin resigns as head of the Law Enforcement Assistance Administration, an arm of the Justice Department. Henry S. Ruth, Jr., director of the National Institute of Criminal Justice in the agency, also resigns. It is rumored that the agency's 3-headed administration has been too cumbersome for efficiency, but no reasons for the resignations are made public.

The Justice Department tells the U.S. Court of Appeals for the Fourth Circuit that the Supreme Court should rule on the constitutionality of operating predominantly black schools in urban areas; the administration allows such schools to continue.

The President charges that the Senate was guilty of "regional discrimination" in refusing to confirm Clement Haynsworth and Carswell to the Supreme Court and says he will not nominate another Southerner to the Court. He terms the tactics of the Senate opposition "vicious."

Apr. 11—*The New York Times* reports that the administration plans to intensify its surveillance of extreme left-wing groups and individuals.

Apr. 13—The President signs a bill authorizing an expenditure of $26.4 billion over the next 3 years for elementary and secondary education; he expresses "considerable reluctance" to sign this most expensive education legislation ever passed.

The Department of Justice warns Florida's Governor Claude R. Kirk, Jr., that "any confrontation between the Governor and the United States would be entirely of his own making." (See also *U.S., Civil Rights, Supreme Court.*)

Apr. 14—The President names Harry Andrew Blackmun of Minnesota as a Justice of the Supreme Court. Blackmun is a member of the U.S. Court of Appeals for the Eighth Circuit and is reportedly regarded by his colleagues as scholarly and mildly conservative.

Apr. 15—The Departments of Defense, Agriculture, Interior, and Health, Education and Welfare act to halt the use of 2,4,5-T as a defoliant in Vietnam and as a weed killer in the U.S. It is reported that the herbicide may produce abnormal development in unborn animals.

The President signs legislation providing a 6 per cent pay increase for all civilian salaried federal employees, including postal workers. The increase is retroactive to December 27 for all civil service workers and postal employees.

Apr. 16—52 Democrats and 52 Republicans sign a formal resolution calling for the establishment of a House committee to consider the possible impeachment of Justice William O. Douglas.

The President asks Congress to adopt

a revised postal system reorganization, including a rise in postal rates to 8¢. The President originally suggested a rise in first class letter rates from 6¢ to 10¢.

Apr. 21—The House Judiciary Committee establishes a subcommittee to study impeachment charges against Douglas.

Apr. 22—The Department of Justice files an antitrust suit against the Westinghouse Electric Corporation and 2 Japanese companies charging that they illegally conspired to prevent sales of certain products in one another's countries.

Apr. 23—By executive order, the President abolishes occupational draft deferments and deferments for fathers; he says he plans to end student deferments when and if Congress so authorizes.

Apr. 27—The director of the Geological Survey, William T. Pecora, declares that his agency unanimously agrees that to bury a hot oil pipeline in the permafrost of Alaska for 90–95 per cent of its 800-mile length is unsafe.

The Senate completes congressional action on a bill extending the power of the Department of the Interior to review federally licensed construction projects affecting the Hudson River.

Labor

Apr. 1—At least 72 trucking companies are shut down as drivers leave their jobs. The contract between the industry and the International Brotherhood of Teamsters expired at midnight. Talks on a new contract are under way.

A contract is signed between table-grape pickers and two growers. This is the first such contract to be won by the pickers in a 5-year effort.

A 60-day tugboat strike ends in New York Harbor.

Apr. 2—A tentative agreement is reached in the trucking contract negotiations.

Nearly 1,700 air traffic controllers are still calling in sick as the work slowdown continues. Airlines are requesting a rearrangement of flight schedules because of airport congestion. (See also *U.S. Govt.*)

Apr. 3—Chicago teamsters reject a tentative agreement for a new contract.

Apr. 7—Federal District Judge George Hart, Jr., rules the air traffic controllers in contempt of court for violating a law forbidding strikes against the federal government.

Apr. 11—Six trucking companies lock out 32,000 drivers in Chicago in a continuing dispute over wages.

Apr. 15—Air traffic returns to near-normal conditions as the traffic controllers return to work.

Apr. 21—United Rubber Workers strike against the Goodyear Tire and Rubber Company.

Apr. 22—A 37-day strike of municipal workers ends in Atlanta, Georgia. Those who were fired by Mayor Sam Massell for refusing to return to work earlier will be rehired without prejudice.

Apr. 27—New York City members of the Patrolmen's Benevolent Association threaten a massive "sick call" campaign because police sergeants were given a raise without more money being granted patrolmen.

Military

Apr. 14—The President names Admiral Thomas H. Moorer, Chief of Naval Operations, to succeed General Earle G. Wheeler as chairman of the Joint Chiefs of Staff.

Apr. 16—Democratic Senator Stephen M. Young of Ohio introduces legislation forcing the Defense Department to make "complete and prior disclosure of all proposed disposals of surplus weapons."

It is reported in Washington that in the 1969 fiscal year the Defense Department gave $470 million in surplus armaments to Greece, Nationalist China, South Korea and Turkey, in addition to the $350 million in military aid approved by Congress.

Apr. 25—It is reported in Washington that local draft boards have been 30 per cent short of their draft quotas in the past 3 months.

Politics

Apr. 1—The New York State Democratic Committee endorses Arthur J. Goldberg as a candidate for Governor. Goldberg, responding to criticism of "boss control," waives the Committee designation and says he will run in the primary on nominating petitions. State Senator Basil Patterson is endorsed for the lieutenant governorship.

Apr. 2—Theodore Sorenson, former aide to the late President John Kennedy, receives the nomination for the post of U.S. Senator by the New York Democratic State Committee. Adam Walinsky, former aide to the late Senator Robert Kennedy, is nominated for the post of State Attorney General.

Apr. 7—A grand jury investigating the July, 1969, drowning of Mary Jo Kopechne, who was a passenger in a car driven by Senator Edward Kennedy, votes no indictment and adjourns. (See *Current History Annual 1970,* p. 103.)

Governor Nelson Rockefeller and Senator Charles Goodell are nominated to run for reelection by the New York State Republican Committee.

Apr. 20—Judge G. Harrold Carswell, recently rejected by the Senate as a candidate for the Supreme Court, says he will run for the post of Senator from the state of Florida.

Science and Space

Apr. 11—Apollo 13 is launched for a moon landing.

Apr. 13—An oxygen tank explodes in Apollo 13, forcing the astronauts to abandon plans for a moon landing.

Apr. 17—Apollo 13 lands safely in the Pacific after 4 days of emergency maneuvers. All 3 astronauts are unharmed.

Supreme Court

Apr. 3—Acting unanimously, the Supreme Court rejects a plea by attorneys for the County Board of Public Instruction in Manatee County, Florida, asking for a delay of the school desegregation plan. (See also *Civil Rights.*)

Apr. 6—The Court rules 7 to 1 that a man once acquitted may not be tried again on essentially the same evidence. Chief Justice Warren Burger dissents, protesting this extension of the constitutional protection against double jeopardy.

The Court rules 5 to 3 that states may constitutionally set limits on the amount of welfare benefits that any family may collect; at issue is a Maryland law.

Apr. 20—The Court dismisses a motion by Governor Claude R. Kirk, Jr., to transfer a Florida school busing case directly to the Supreme Court from the federal courts. (See also *Civil Rights.*)

The Court refuses to review a lower court ruling forbidding the Subversive Activities Control Board to declare that individuals are members of the Communist party. The 20-year-old board was established to register and publish the names of Communists.

Apr. 23—The Court agrees that on May 4 it will hear arguments in a case involving capital punishment; the case has been postponed for almost a year because of the vacancy on the Court.

VATICAN

Apr. 28—In a 2,800-word statement, Pope Paul revises the regulations for marriage between Catholics and non-Catholics. The non-Catholic partner will no longer be required to promise to raise offspring in the Catholic church.

VIETNAM, REPUBLIC OF (South)

(See also *Intl. War in Vietnam, U.S., Foreign Policy*)

Apr. 29—The Supreme Court of South Vietnam rules that a 1962 government decree establishing a special military tribunal with power to try civilian cases is unconstitutional.

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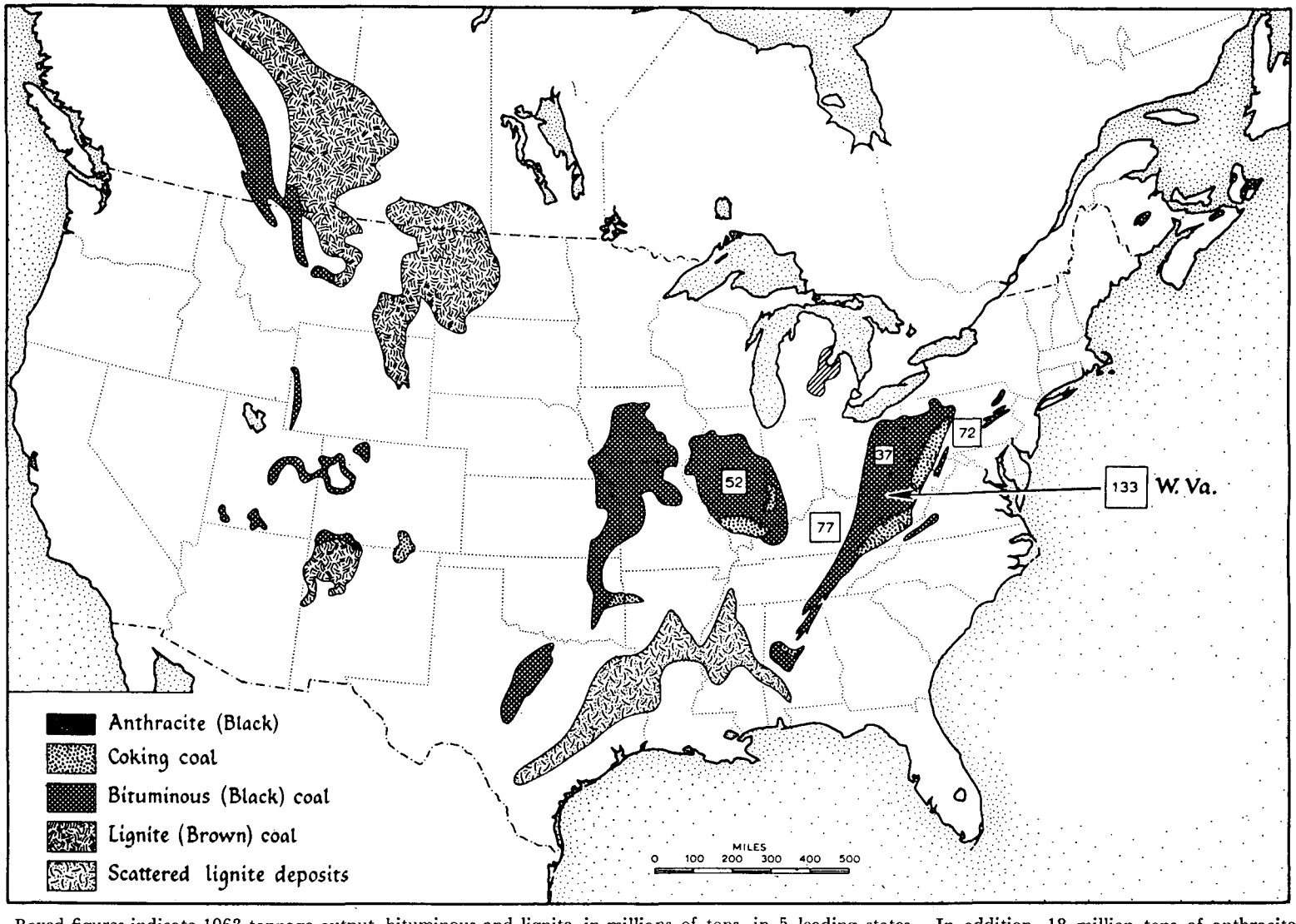
SUBJECTS

AUTHORS



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